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The Society of the
Plastics Industry, Inc.

SPI

1983 edition

Facts & Figures of the U.S. Plastics Industry

SPI'S COMMITTEE ON RESIN STATISTICS

The Committee on Resin Statistics, only one of the more than sixty Operating Units within the Society of the Plastics Industry is composed of 100 representatives from plastics resin producing companies, trade publications, industry-related professional organizations, and various agencies of the Federal government. All members of the Committee are quite knowledgeable of the rapidly growing plastics industry and have a special interest in the development of marketing and economic data.

At present the Committee is responsible for the development and maintenance of a monthly report on the major plastics materials. This report shows monthly and cumulative data on Production and Sales & Use (including captive operations) with percent change from the previous year. It is the only detailed monthly report on plastics materials now available. There are one hundred twenty-five producers participating in the monthly program and they are believed to represent about 95% of total U.S. plastics production. Many of the materials covered reflect 100% industry coverage. The data are compiled by Ernst & Whinney, nationally renowned Independent Public Accountants.

The Committee is actively involved with the various departments of the Federal Government (International Trade Commission, Department of Commerce, Burean of Census, Department of Energy, Bureau of Labor Statistics, etc.) assisting them in the development and improvement of the plastics segments of their special reports.

The Committee is also responsible for monitoring all resin data which appear in FACTS & FIGURES, thus assuring the most accurate and timely data available on the plastics industry.

1983 edition

Facts & Figures of the U.S. Plastics Industry

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THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

The Society of the Plastics Industry, Inc. is a member-run federation dedicated to promoting and protecting continuing growth for the plastics industry in the United States. The Society represents more than 1,400 member companies responsible for over 95 percent of plastics materials production and 75 percent of U.S. plastics product sales.

SPI's 70 operating units and more than 300 committees have membership drawn from all segments of the industry—processors, resin and adjuvant suppliers, plastics distributors, machinery builders, and moldmakers. The Society serves as a federation of semi-autonomous, interrelated groups with a strong, common interest in the overall health of the plastics industry.

SPI serves as the "industry spokesman." It identifies and provides positive responses to misinformation and to potentially harmful regulations, bills, or court decisions by mobilizing pertinent facts and carrying out programs for timely and forceful action. At the same time, SPI works to prevent such damaging situations from occurring by building a positive understanding of the industry. The Society's service committees provide liaison with government agencies, code and regulatory groups, and many other associations.

SPI sponsors research projects in areas such as energy use, resource recovery, combustibility, and worker safety, at major private research organizations. The Society conducts numerous information programs, providing literature, surveys, reports, newsletters, and handbooks for industry and public use.

SPI sponsors one of the largest trade shows in the United States—the National Plastics Exposition, held every three years. The next show will be held in June 1985, again at McCormick Place in Chicago.

Incorporated in 1937, SPI has grown with the dynamic industry it represents. In addition to the Society's headquarters office in New York City, SPI has five section offices: Eastern Section, 169 Union Boulevard, Totowa, NJ 07512; New England Section, 20 Speen Street, Framingham, MA 01701; Midwestern Section, 3150 Des Plaines Avenue, Des Plaines, IL 60018; Washington, D.C. Office, 605 14th Street, N.W., Washington, D.C. 20005, and Western Section, Saddleback Square, Suite 124, 12440 Firestone Boulevard, Norwalk, CA 90650.

SPI draws together the diverse segments of the plastics industry into an effective organization that represents the entire industry.

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DEVELOPMENT OF TODAY'S PLASTICS

Today's plastics are one of the most used material on a volume basis in America's industrial and commercial life. The role of plastics is so broadly integrated in our own lifestyle that today there is virtually no product area where plastics do not make a major, irreplaceable contribution. Although the plastics industry in the United States is now in its second century, the most important developments have occurred since 1910. However, the roots of these modern developments go back not only to the research of cellulose nitrate by John Wesley Hyatt in the 1860's, but also to the plastic-like compositions used by man through the centuries.

ORIGIN OF PLASTICS

One can go as far back as the Old Testament to find references about natural materials used as fillers, adhesives, coatings, and the like. These materials were the precursors of what we call plastic materials today. Consequently, historians differ as to the exact date that the plastics industry began, and they will continue to do so since an exact year or even decade for the event is a matter of interpretation as to what constitutes a "plastic."

Certainly the history of the rubber industry has a bearing on plastics since ebonite, or hard rubber, discovered in 1851, was the first thermosetting material to be prepared and also the first material which involved a distinct chemical modification of a natural material. But ebonite was not exploited commercially for some years after its discovery and for that reason its historical importance has become somewhat blurred.

EUROPEAN DEVELOPMENTS

While the basic processes of rubber technology were developing, other important discoveries were taking place in Europe. Following work by Pelouze, Schonbein was able to establish conditions of controlled nitration of cellulose. The product soon became of interest as an explosive and in the manufacture of collodion, a cellulose solution in an alcohol-ether mixture. In the 1850's the English inventor Alexander Parkes observed that the solid residue left after the evaporation of the solvent of photographic collodion was a "hard, horny elastic and waterproof substance." In 1856 he patented the process of waterproofing woven fabrics by the use of such materials.

In 1862 the Great International Exhibition was held in London. It was there that Parkes introduced a new material named for himself—Parkesine. Parkesine was obtained by dissolving cellulose nitrate in a minimum of solvent. The mixture was then put on a heated rolling machine from which some of the solvent was then removed. While still in the plastic state the material was then shaped by dies or pressure. In 1866 Parkes organized the Parkesine Company to manufacture products from his new material, but the company failed in 1868. This appears in part due to Parkes' attempt to reduce production costs which resulted in the production of inferior items.

One year after the failure of the Parkesine Company, an associate of Parkes, Daniel Spill, formed the Xylonite Company to manufacture products similar to Parkesine. Once again economic failure resulted and Spill's company went bankrupt in 1874. Undaunted, Spill moved to a new site, established the Daniel Spill Company and continued production of his material, Xylonite.

FIRST PLASTICS IN THE U.S.

In the United States during the 1860's someone else was experimenting with cellulose nitrate—John Wesley Hyatt. In 1865 Hyatt became involved in devising a method for producing billiard balls from materials other than ivory. Originally using mixtures of cloth, ivory dust and shellac, in 1869 he patented the use of collodion for coating billiard balls. The patent came one year after his collodion material was introduced commercially.

John W. Hyatt and his brother Isaiah took out U.S. Patent 105,338 in 1870 for a process of producing a horn-like material using cellulose nitrate and camphor. Although Parkes and Spill had mentioned camphor in their work it was the Hyatt brothers who recognized the value of camphor as a plasticizer for cellulose nitrate. In 1872 the term celluloid was coined by Isaiah Hyatt to describe the Hyatts' commercially successful product.

The validity of Hyatts' patents was challenged by Spill and a number of court actions took place between 1877 and 1884. In the final action it was found that Spill had no claim on the Hyatt brothers, the judge ruling that the true inventor of the process was Parkes since he (Parkes) had mentioned the use of camphor in his patents. Thus, there was no restriction on the use of these processes and any company, including the Hyatts' Celluloid Manufacturing Company, were free to use them. After that decision the Celluloid Manufacturing Company prospered, changed its name to the American Celluloid Chemical Corporation, and eventually was absorbed by the Celanese Corporation.

FORMALDEHYDE RESINS

Next to cellulose nitrate the most important material in the early history of plastics was formaldehyde. Around 1897 there was a demand in German schools for a white chalkboard. Efforts to obtain such a product resulted in the discovery of casein plastics, produced by reacting casein (milk protein) with formaldehyde. The material soon became established under the trade names of Galalith and Erinoid, and today casein is still used by the button industry.

In 1899 Arthur Smith took out British Patent 16,274, the first dealing with phenol-formaldehyde resins, in this case for use as an ebonite substitute in electrical insulation. During the next decade the phenol-formaldehyde reaction was investigated mainly for academic interest. In 1907 however, Leo Hendrik Baekeland discovered techniques of so controlling and modifying the reaction that useful products could be made from it. Thus phenolics were the first fully synthetic resins to become commercially successful.

Prompted by the success of phenolic moldings, research began on reacting other materials, such as urea and thiourea, with formaldehyde. These materials were used in the manufacture of molding powders. Unlike the phenolics, they could be molded into light-colored articles and they rapidly achieved commercial success. Today these urea-based resins are used for molding powders, adhesives, and textile and paper finishing while the related melamine-formaldehyde resins are used in decorative laminates.

GROWTH OF MODERN PLASTICS

Cellulose acetate, a thermoplastic, was developed about the same time as the urea-based resins. Similar in structure to cellulose nitrate, it was found to be safer in processing and use. Cellulose acetate was introduced as a molding compound in 1927.

The period 1930-1940 saw the initial commercial development of today's major thermoplastics; polyvinyl chloride; low density polyethylene; polystyrene; and polymethyl methacrylate. The advent of the Second World War in 1939 brought plastics into great demand, largely as substitutes for materials in short supply, such as natural rubber. In the United States the crash program leading to large-scale production of synthetic rubbers resulted in extensive research into the chemistry of polymer formation, and eventually, to the development of more plastic materials.

The first decade after World War II saw the development of high density polyethylene and polypropylene and the growth of the newer plastics in many applications. Large-scale production of these materials reduced their cost dramatically. The new materials began to compete with the older plastics and even with the more traditional materials such as wood, paper, metal, glass and leather. Since that time the demand for plastics has increased steadily so that plastics are now accepted by designers and engineers as basic materials along with the more traditional materials. The automotive industry, for instance, relies on plastics to reduce weight and thus increase mileage.

INTRODUCTION OF PLASTICS RESINS

DATE	MATERIAL	EXAMPLE
1868	Cellulose Nitrate	Eye Glass Frames
1909	Phenol-Formaldehyde	Telephone Handset
1919	Casein	Knitting Needles
1926	Alkyd	Electrical Bases
1927	Cellulose Acetate	Tooth Brushes
1927	Polyvinyl Chloride	Wall Covering
1929	Urea-Formaldehyde	Lighting Fixtures
1935	Ethyl Cellulose	Flashlight Cases
1936	Acrylic	Brush Backs
1936	Polyvinyl Acetate	Flash Bulb Lining
1938	Cellulose Acetate Butyrate	Packaging
1938	Polystyrene	Housewares
1939	Nylon	Gears
1939	Polyvinylidene Chloride	Packaging Film
1939	Melamine-Formaldehyde	Tableware
1942	Unsaturated Polyester	Boat Hulls
1942	Low Density Polyethylene	Packaging
1943	Fluoropolymers	Industrial Gaskets
1943	Silicone	Motor Insulation
1945	Cellulose Propionate	Pens and Pencils
1947	Epoxy	Tools and Jigs
1948	Acrylonitrile-Butadiene-Styrene (ABS)	Luggage
1954	Styrene-Acrylonitrile (SAN)	Housewares
1954	Polyurethane	Foam Cushions
1956	Acetal	Automotive Parts
1957	High Density Polyethylene	Milk Bottles
1957	Polypropylene	Safety Helmets
1957	Polycarbonate	Appliance Parts
1959	Chlorinated Polyether	Valves and Fittings
1962	Phenoxy	Bottles
1964	Ionomer	Skin Packaging
1964	Polyphenylene Oxide	Battery Cases
1964	Polyimide	Bearings
1964	Ethylene-Vinyl Acetate	Adhesives and Coatings
1965	Polysulfone	Electrical/Electronic Parts
1970	Thermoplastic Polyester	Electrical/Electronic Parts
1973	Polybutylene	Piping
1973	Polyphenylene Sulfide	Telecommunications
1974	Polyethersulfone	Printed circuit boards
1975	Nitrile Barrier Resins	Non-food Packaging
1978	Linear Low Density Polyethylene	Extruded Film
1982	Polyetherimide	Electrical/Electronic Parts

1982 IN REVIEW—PRODUCTION AND SALES & CAPTIVE USE*
(in millions of pounds)

Resin	Production			Sales & Captive Use		
	1982	1981	% Change	1982	1981	% Change
Epoxy	286	336	—14.9	301	332	— 9.3
Phenolic	2,006	2,333	—14.0	2,060	2,375	—13.3
Polyester	865	997	—13.2	851	977	—12.9
Urea	998	1,165	—14.3	976	1,139	—14.3
Melamine	158	179	—11.7	155	175	—11.4
Total Selected Thermosets	4,313	5,010	—13.9	4,343	4,998	—13.1
ABS	740	916	—19.2	737	900	—18.1
SAN	91	107	—15.0	85	105	—19.0
HDPE	4,928	4,695	+ 5.0	5,024	4,683	+ 7.3
LDPE	7,503	7,693	—2.5	7,687	7,516	+ 2.3
Nylon	228	312	—26.9	247	288	—14.2
Polypropylene	3,477	3,955	—12.1	3,623	3,888	— 6.8
Polystyrene	3,191	3,621	—11.9	3,200	3,604	—11.2
PVC	5,326	5,707	— 6.7	5,455	5,601	— 2.6
Thermoplastic Polyester	648	610	+ 6.2	619	581	+ 6.5
Total Selected Thermoplastics	26,132	27,616	— 5.4	26,677	27,166	— 1.8
Total Selected Plastics	30,445	32,626	— 6.7	31,020	32,164	— 3.6
All Other Plastics	6,162	7,241	—14.9	4,089	4,792	—14.7
Grand Total	36,607	39,867	— 8.2	35,109	36,956	— 5.0

*Excludes Polyurethane.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

1982 IN REVIEW—
DISTRIBUTION OF SALES & CAPTIVE USE BY MAJOR MARKET
(in millions of pounds)

Major Market	1982	1981	% Change	Share of Total 1982	Share of Total 1981
Transportation	1,392	1,573	—11.5	4.0%	4.3%
Packaging	10,497	10,465	+ 0.3	29.9	28.3
Building/Construction	7,154	7,259	— 1.4	20.4	19.6
Electrical/Electronic	2,275	2,670	—14.8	6.5	7.2
Furniture/Furnishings	1,556	1,670	— 6.8	4.4	4.5
Consumer/Institutional	3,269	3,670	—10.9	9.3	9.9
Industrial/Machinery	241	393	—38.7	0.7	1.1
Adhesives, Inks & Coatings	1,584	2,572	—38.4	4.5	7.0
Other	3,232	3,259	— 0.8	9.2	8.8
Exports	3,909	3,425	+14.1	11.1	9.3
Total	35,109	36,956	— 5.0	100.0%	100.0%

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

TOTAL U.S. PRODUCTION AND SALES & CAPTIVE USE OF PLASTICS RESIN: 1957-1982
(in millions of pounds)

YEAR	PRODUCTION (Excluding Polyurethane)	POLYURETHANE PRODUCTION[d]	PRODUCTION (Including Polyurethane)	SALES & CAPTIVE USE (Excluding Polyurethane)
[a]1957	4,385	17	4,402	3,740
1958	4,578	33	4,611	4,003
1959	5,925	67	5,992	5,097
1960	6,226	95	6,321	5,277
1961	6,780	150	6,930	5,905
1962	7,977	220	8,197	6,952
[b]1963	9,084	280	9,364	7,380
1964	10,230	295	10,525	8,581
1965	11,829	390	12,219	10,684
1966	13,719	480	14,199	11,294
1967	13,923	550	14,473	11,789
1968	16,581	650	17,231	14,811
1969	18,935	785	19,720	15,788
1970	19,226	830	20.056	16,747
[c]1971	20,201	960	21,161	18,949
1972	25,285	1,190	26,475	24,433
1973	27,783	1,430	29,213	27,432
1974	27,944	1,330	29,274	26,693
1975	21,588	1,240	22,828	21,162
1976	27,646	1,550	29,196	26,984
1977	32,098	1,850	33,948	31,106
1978	35,655	1,950	37,605	35,063
1979	39,477	2,100	41,577	38,717
1980	35,447	1,900	37,347	35,186
1981	37,817	2,050	39,867	36,956
1982	34,907	1,700	36,607	35,109

[a]U.S. Tariff Commission data used for 1957-1970. May exclude some captive use.
[b]Celluiosics not included through 1962. Included beginning in 1963.
[c]SPI data used for 1971-1982.
[d]***Chemical Economics Handbook,*** SRI International, Menlo Park, Cal.

Compound Growth Rate

Years	Total Production	Sales & Captive Use
1957-1982	8.8%	9.6%
1967-1982	6.4%	8.0%
1972-1982	3.3%	3.7%
1977-1982	5.1%	5.0%
1981-1982	— 8.2%	—5.0%

TOTAL U.S. PLASTICS PRODUCTION AND SALES & CAPTIVE USE BY RESIN*

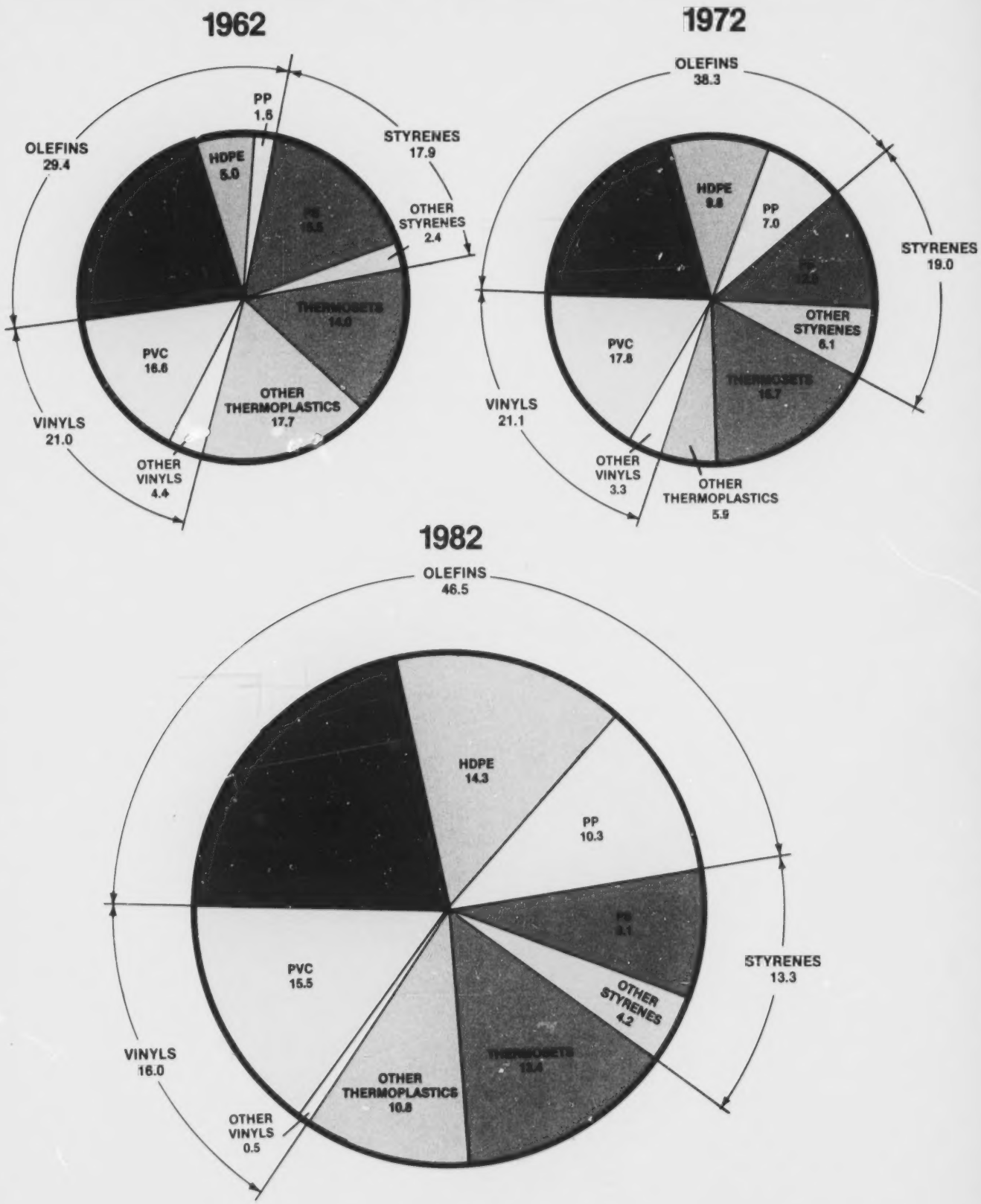
(in millions of pounds)

Resin	1978		1979		1980		1981		1982		Compound Growth Rate 1977-1982 Sales & Captive Use
	Production	Sales & Captive Use	Production	Sales & Captive Use	Production	Sales & Captive Use	Production	Sales & Captive Use	Production	Sales & Captive Use	
Epoxy	299	316	361	332	315	319	336	332	286	301	1.6%
Phenolic	1,617	1,543	1,781	1,732	1,499	1,517	2,333	2,375	2,006	2,060	**
Polyester	1,209	1,199	1,147	1,152	947	949	997	977	865	851	– 4.0
Urea	1,122	1,103	1,367	1,355	1,165	1,147	1,165	1,139	998	976	0.5
Melamine	202	196	200	192	167	166	179	175	158	155	– 5.2
Total Selected Thermosets	4,449	4,357	4,856	4,763	4,093	4,098	5,010	4,998	4,313	4,343	2.3
ABS	1,134	1,118	1,191	1,183	920	916	916	900	740	737	– 7.0
SAN	120	121	124	126	111	103	107	105	91	85	– 5.5
HDPE	4,201	4,165	5,010	4,893	4,405	4,394	4,695	4,683	4,928	5,024	7.2
LDPE	7,111	7,147	7,793	7,815	7,291	7,467	7,693	7,516	7,503	7,687	3.4
Nylon	275	278	327	315	274	271	312	288	228	247	– 0.3
Polypropylene	3,074	3,055	3,841	3,894	3,648	3,714	3,955	3,888	3,477	3,623	6.1
Polystyrene	3,823	3,870	4,005	3,997	3,521	3,518	3,621	3,604	3,191	3,200	– 2.1
PVC	5,723	5,810	6,119	6,138	5,470	5,407	5,707	5,601	5,326	5,455	– 2.1
Thermoplastic Polyester	—	—	—	—	503	511	610	581	648	619	—
Total Selected Thermoplastics	25,461	25,564	28,410	28,361	26,143	26,301	27,616	27,166	26,132	26,677	3.1
Total Selected Plastics	29,910	29,921	33,266	33,124	30,236	30,399	32,626	32,164	30,445	31,020	3.0
All Other Plastics	7,695	5,142	8,311	5,593	7,111	4,786	7,241	4,792	6,162	4,089	– 0.7
Grand Total	37,605	35,063	41,577	38,717	37,347	35,185	39,867	36,956	36,607	35,109	2.5%

*Sales & Captive Use excludes Polyurethane. **Not applicable since reporting on gross weight basis begun in 1981.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

PERCENTAGE DISTRIBUTION OF PLASTIC SALES & CAPTIVE USE BY MATERIAL



PLASTICS RESINS DOMESTIC MERCHANT SALES
(in millions of dollars and millions of pounds)

Resin	1982		1981		% Change	
	Net Dollar Value	Quantity	Net Dollar Value	Quantity	Net Dollar Value	Quantity
Low Density Polyethylene	$ 1,756	5,815	$ 2,077	5,748	−15.5	+ 1.2
High Density Polyethylene	1,350	4,106	1,414	3,786	− 4.5	+ 8.5
Polystyrene	1,210	2,766	1,446	3,104	−16.3	−10.9
Polyvinyl Chloride	1,031	4,353	1,244	4,413	−17.1	− 1.4
Polypropylene	923	2,430	1,015	2,636	− 9.1	− 7.8
ABS	530	685	635	845	−16.5	−18.9
Unsaturated Polyester	508	835	549	913	− 7.5	− 8.5
Other Styrenes	395	524	488	656	−19.1	−20.1
Thermoplastic Polyester	391	563	357	538	+ 9.5	+ 4.6
Phenolic	328	1,394	449	1,979	−26.9	−29.6
Epoxy	317	262	338	291	− 6.2	−10.0
Nylon	315	208	367	249	−14.2	−16.5
Urea	176	868	231	1,130	−23.8	−23.2
Other Vinyls	114	81	125	100	− 8.8	−19.0
Melamine	100	123	108	131	− 7.4	− 6.1
SAN	51	72	58	87	−12.1	−17.2
All other (excluding polyvinyl acetate and polyurethane)	2,870	1,843	2,758	2,660	+ 4.1	−30.7
Total	$12,365	26,928	$13,404	28,838	− 7.8	− 6.6

Domestic merchant sales are quantities of sales excluding interplant transfers, captive consumption and exports.

Net dollar value represents the actual selling price after deductions for cash discounts, quantity discounts, returned goods and allowances, federal excise taxes, local taxes, and outgoing transportation (prepaid or otherwise) to warehouses or customers.

Source: SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

APPARENT U.S. CONSUMPTION OF SELECTED PLASTICS RESINS

Apparent consumption is calculated by adding imports to production then subtracting exports. It is an accurate measure of the quantity of material actually consumed in the United States.

For purposes of the table below, the production figures were taken from SPI's Monthly Statistical Report, as compiled by Ernst & Whinney. Both the import and export figures were taken from Bureau of the Census reports.

1982
(in millions of pounds)

Resin	Production	Imports	Exports	Apparent Consumption
Low Density Polyethylene	7,503	36	1,224	6,315
Polyvinyl Chloride	5,326	116	561	4,881
High Density Polyethylene	4,928	26	951	4,003
Polystyrene & Styrene Copolymers	3,922	20	170	3,772
Polypropylene	3,477	6	809	2,674
Phenolic	2,006	18	37	1,987
Urea	998	7	6	999
Unsaturated Polyester	865	2	24	843
ABS	740	13	59	694
Thermoplastic Polyester[a]	648	6	73	581
Nylon	228	6	33	201
Epoxy	286	5	101	190
Melamine	158	2	13	147
Other Vinyls	177	5	41	141
Total of these resins	31,262	268	4,102	27,428
1981 Total	33,696	307	3,596	30,407
1980 Total	31,247	247	4,194	27,300
1979 Total	34,550	273	3,625	31,198
1978 Total	31,101	234	2,302	29,033
1977 Total	28,077	136	1,978	26,235
1976 Total	25,565	135	2,185	23,515

[a]Not included in total 1976-1979.

Source: Production—SPI Monthly Statistical Report, as compiled by Ernst & Whinney
Imports—Bureau of the Census, IM 146
Exports—Bureau of the Census, EM 546

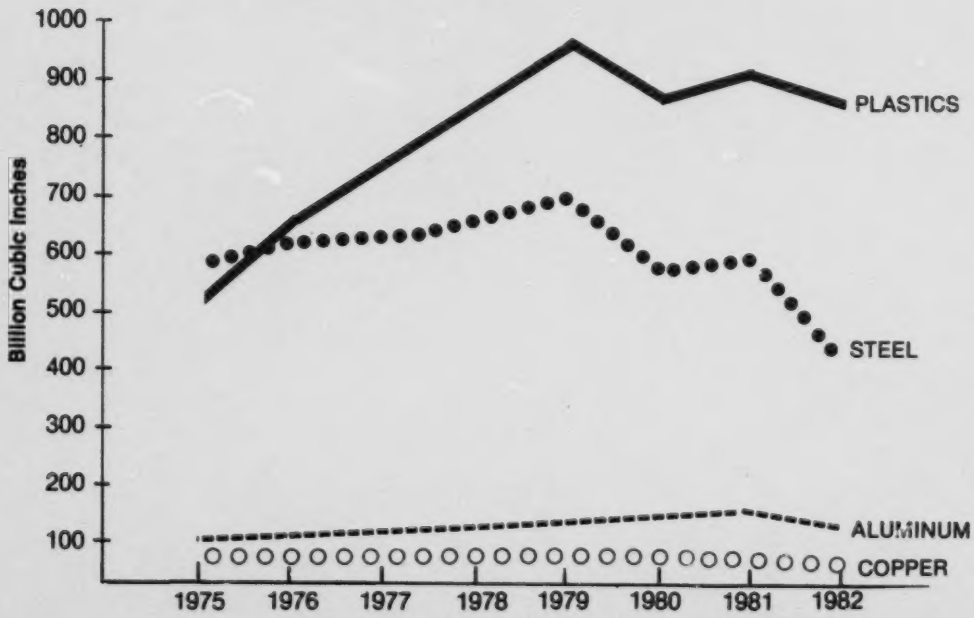
PLASTICS MATERIALS & RESINS
VALUE OF SHIPMENTS
(in millions of dollars)

Versus Largest Chemical Categories	1978	1979	1980r	1981r	1982	Compound Growth Rate 1977-1982
Industrial Organic Chemicals	26,350	32,700	33,825	37,200	29,650	4.2%
Drugs	16,300	17,300	19,900	22,700	25,600	12.4%
Plastics Materials & Resins	12,000	14,300	14,900	16,400	14,200	5.6%
Industrial Inorganic Chemicals	9,800	10,600	12,100	13,050	12,850	8.1%
Soaps & Detergents	6,400	6,900	8,300	9,400	10,800	13.8%
Cosmetics	7,200	7,400	7,900	8,850	9,850	8.5%
Paints & Allied Products	7,150	7,900	8,350	9,200	8,900	6.2%
Cyclic Crudes & Intermediates	5,700	6,250	7,580	8,000	6,050	1.4%
Phosphatic Fertilizers	2,850	3,500	4,500	4,500	3,800	7.1%
Nitrogenous Fertilizers	2,650	2,650	3,400	3,600	3,500	6.1%

Versus Other Commodities	1978	1979	1980r	1981r	1982	Compound Growth Rate 1977-1982
Steel	58,050	65,950	60,200	66,800	51,900	0.9%
Paper and Board	22,900	25,450	28,700	32,000	30,800	8.8%
Cement and Concrete	15,950	18,150	18,000	18,500	18,000	6.2%
Aluminum	15,900	18,900	19,900	20,500	17,800	6.3%
Plastics Materials & Resins	12,000	14,300	14,900	16,400	14,200	5.6%
Glass Containers	4,050	4,200	4,500	4,800	5,100	6.9%
Primary Copper	4,200	5,750	5,500	5,350	3,750	– 0.8%
Synthetic Rubber	2,000	2,650	2,650	3,100	3,200	11.6%
Leather Tanning & Finishing	1,575	1,800	1,800	1,750	1,450	0.0%
Primary Lead	850	1,350	1,600	1,300	900	5.2%

r = revised from 1982 edition.
Source: Department of Commerce estimates.

SHIPMENTS BY VOLUME: PLASTICS VS METALS



NOTE: Factors used in conversion—steel = .289 lbs/cu in
plastics = .04 lbs/cu in
aluminum = .098 lbs/cu in
copper = .321 lbs/cu in

NOTE: Plastics do not include polyurethane
SOURCE: American Iron and Steel Institute
SPI
U.S. Bureau of the Census

PLASTICS MATERIALS AND RESINS (SIC 2821): TRENDS AND PROJECTIONS

(in millions of dollars except as noted)

Item	1972	1977	1979	1980	1981[1]	1982[2]	Compound annual rate of growth 1972-1982	1983[3]	Percent change 1982-83[3]
Industry data									
Value of shipments[4]	4,478.2	10,818.2	14,282.4	14,908.2	16,400	14,200	—	—	—
Value of shipments (1972 $)[4]	4,478.2	5,060.0	5,607.5	4,974.4	5,240	4,500	0.1	4,750	5.6
Total employment (000)	54.8	57.2	60.3	58.8	57.6	56.3	0.3	56.6	0.5
Production workers (000)	35.0	36.7	38.4	36.6	35.3	34.4	−0.2	34.7	1.0
Average hourly earnings of production workers ($)	4.98	7.52	8.86	9.73	10.70	11.55	8.7	—	—
Capital expenditures	253.2	895.2	1,077.1	1,323.2	—	—	—	—	—
Product data									
Value of shipments[5]	4,486.4	12,181.1	16,964.2	18,013.8	19,640	17,090	—	—	—
Value of shipments (1972 $)[5]	4,486.4	5,546.9	6,487.3	5,842.9	6,150	5,290	1.7	5,600	5.9
Product price index (1972 = 100)	100.0	219.5	261.5	308.3	319.3	323.1	—	—	—
Quantity produced (million lbs.)	25,921	34,623	41,871	38,186	40,600	34,350	2.8	36,400	6.0
Trade									
Value of exports	438.9	1,057.2	2,183.3	2,703.4	2,554.5	2,265.8	—	2,290	1.1
Value of imports	56.4	106.3	246.4	263.4	288.1	262.0	—	290	10.7
Export/shipments ratio	0.098	0.087	0.129	0.147	0.130	0.133	—	—	—
Import/new supply ratio[6]	0.012	0.009	0.014	0.014	0.014	0.015	—	—	—

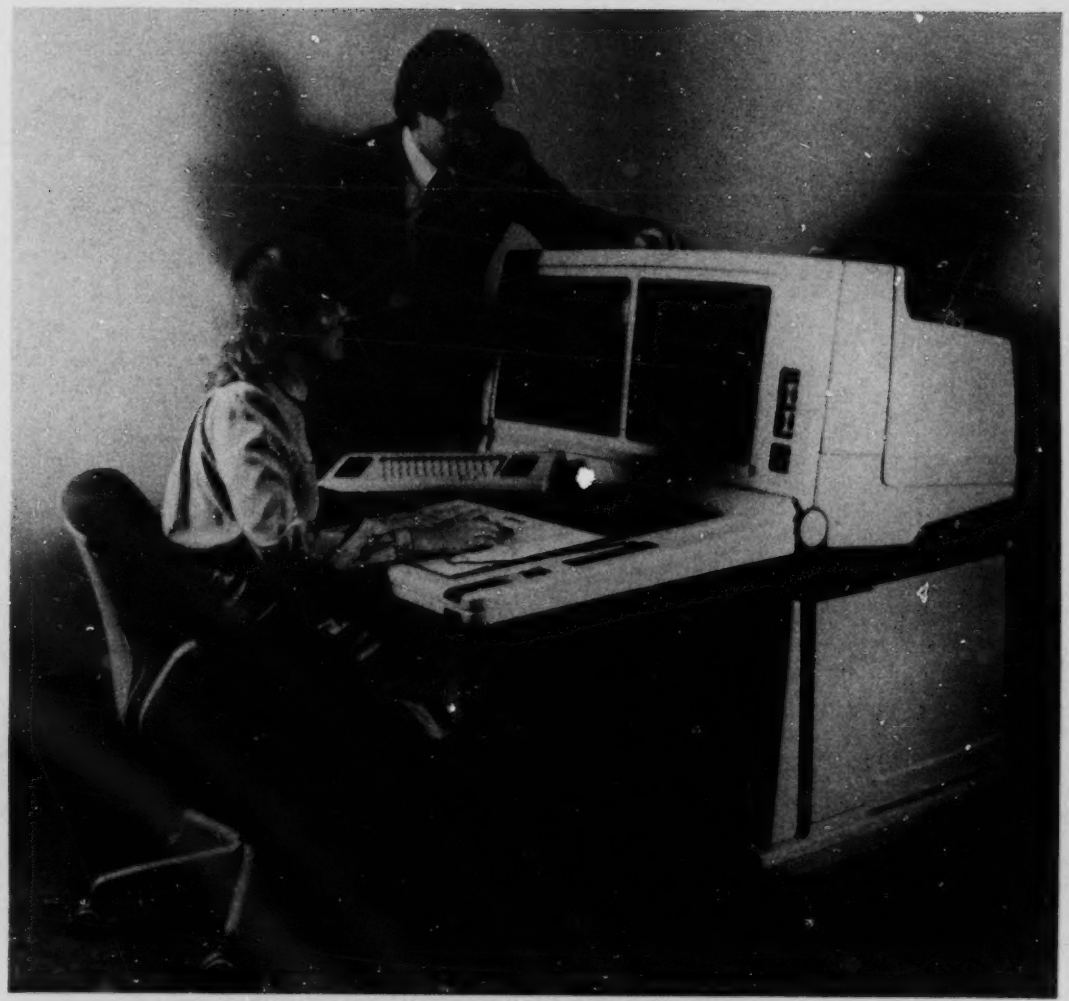
[1] Estimated except for product price index, exports, and imports.
[2] Estimated.
[3] Forecast.
[4] Value of all products and services sold by industry SIC 2821.
[5] Value of shipments of plastics materials, synthetic resins and non-vulcanizable elastomers produced by all industries.
[6] New supply is the sum of product shipments plus imports.
Source: Bureau of the Census and Bureau of Industrial Economics.
Estimates and forecasts by the Bureau of Industrial Economics.

MISCELLANEOUS PLASTICS PRODUCTS (SIC 3079): TRENDS AND PROJECTIONS

(in millions of dollars except as noted)

Item	1972	1977	1979	1980	1981[1]	1982[2]	Compound annual rate of growth 1972-1982	1983[3]	Percent change 1982-83[3]
Industry data									
Value of shipments[4]	10,696	23,693	29,116	30,583	33,050	32,350	—	—	—
Value of shipments (1972 $)[4]	10,696	14,571	15,705	15,021	15,450	14,700	3.2	15,225	3.6
Total employment (000)	347	454	488	470	484	460	2.9	470	2.2
Production workers (000)	276	358	387	369	382	358	2.6	368	2.8
Average hourly earnings of production workers ($)	3.27	4.66	5.29	5.80	6.36	6.76	7.5	—	—
Capital expenditures	654	1,154	1,503	1,463	—	—	—	—	—
Product data									
Value of shipments[5]	11,094	23,879	29,348	30,271	32,750	31,900	—	—	—
Value of shipments (1972 $)[5]	11,094	14,686	15,830	14,868	15,310	14,500	2.7	15,025	3.6
Product price index (1972 = 100)	100.0	166.4	192.1	212.0	214.0	220.0	—	—	—

[1] Estimated except for product price index.
[2] Estimated.
[3] Forecast.
[4] Value of all products and services sold by industry SIC 3079.
[5] Value of shipments of plastics products produced by all industries.
Source: Bureau of the Census and Bureau of Industrial Economics.
Estimates and forecasts by the Bureau of Industrial Economics.
Source: *1983 U.S. Industrial Outlook*, U.S. Department of Commerce.



Courtesy: General Electric Company and *Plastics World Magazine*

Intergraph CAD/CAM station of Noryl® foam

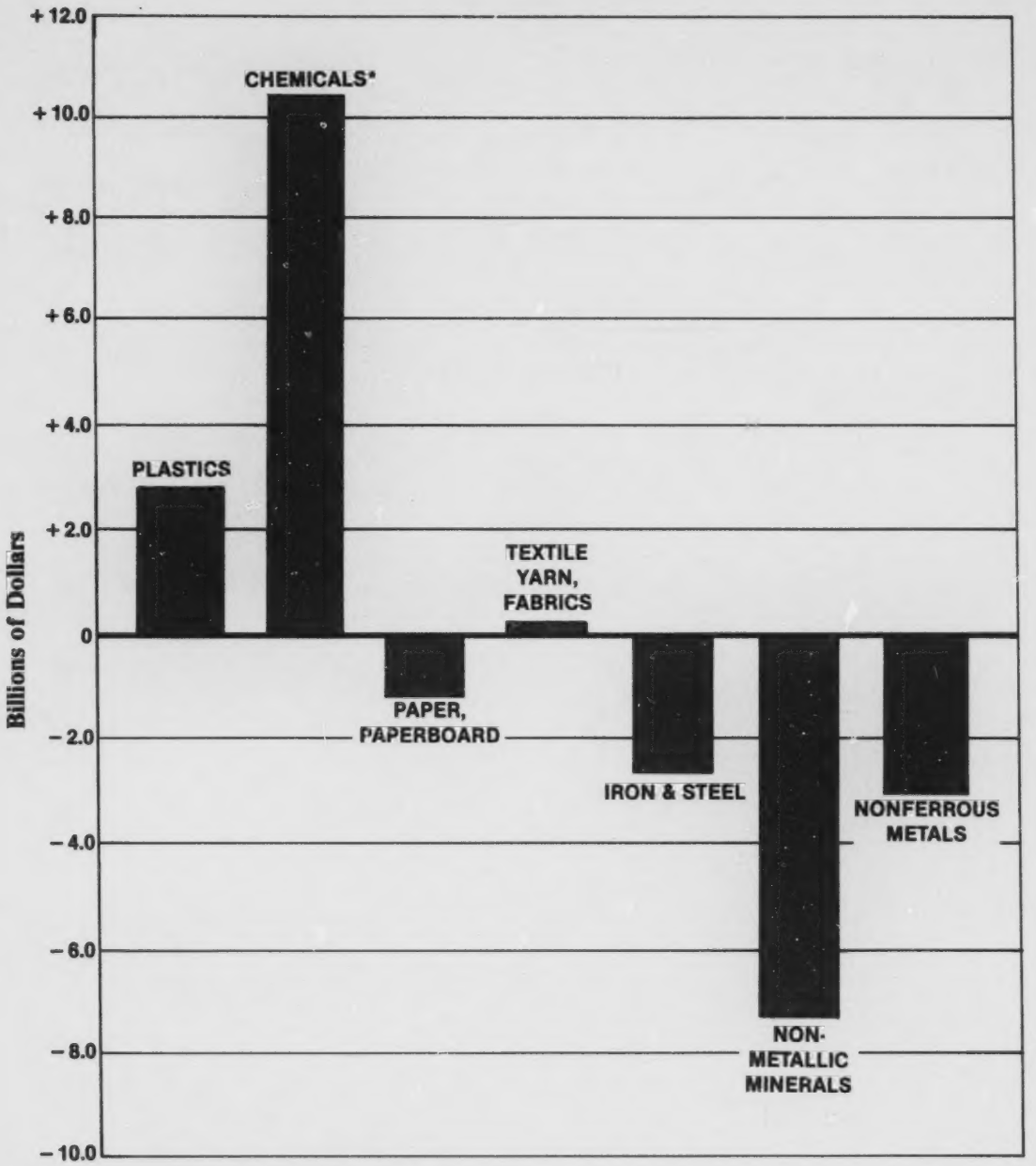
GENERAL ECONOMIC STATISTICS

COMMODITY — BALANCE OF TRADE
(in millions of dollars)

	Exports	Imports	Difference
Plastics Materials & Resins			
1978	2,088	566	+1,522
1979	3,240	641	+2,599
1980	3,884	652	+3,232
1981	3,809	779	+3,030
1982	3,650	766	+2,884
Chemicals (except plastics)			
1978	10,530	6,212	+4,318
1979	14,066	6,877	+7,189
1980	16,356	7,891	+8,465
1981	17,378	8,543	+8,835
1982	16,240	8,727	+10,397
Paper, Paperboard			
1978	1,597	3,024	−1,427
1979	1,967	3,331	−1,364
1980	2,831	3,534	−703
1981	2,961	3,822	−861
1982	2,653	3,848	−1,195
Textile Yarn, Fabrics			
1978	2,225	2,400	−175
1979	3,189	2,237	+952
1980	3,632	2,504	+1,128
1981	3,619	3,043	+576
1982	2,784	2,807	−23
Iron and Steel			
1978	1,714	8,034	−6,320
1979	2,342	7,620	−5,278
1980	3,122	7,509	−4,387
1981	2,880	11,238	−8,358
1982	1,804	4,487	−2,683
Nonmetallic Minerals, n.e.c.			
1978	1,597	4,086	−2,489
1979	1,949	4,065	−2,116
1980	2,209	4,680	−2,471
1981	2,194	4,890	−2,696
1982	2,168	9,612	−7,444
Nonferrous Metals			
1978	1,281	5,259	−3,978
1979	2,152	6,314	−4,162
1980	4,743	7,612	−2,869
1981	2,594	6,947	−4,353
1982	2,094	5,320	−3,226

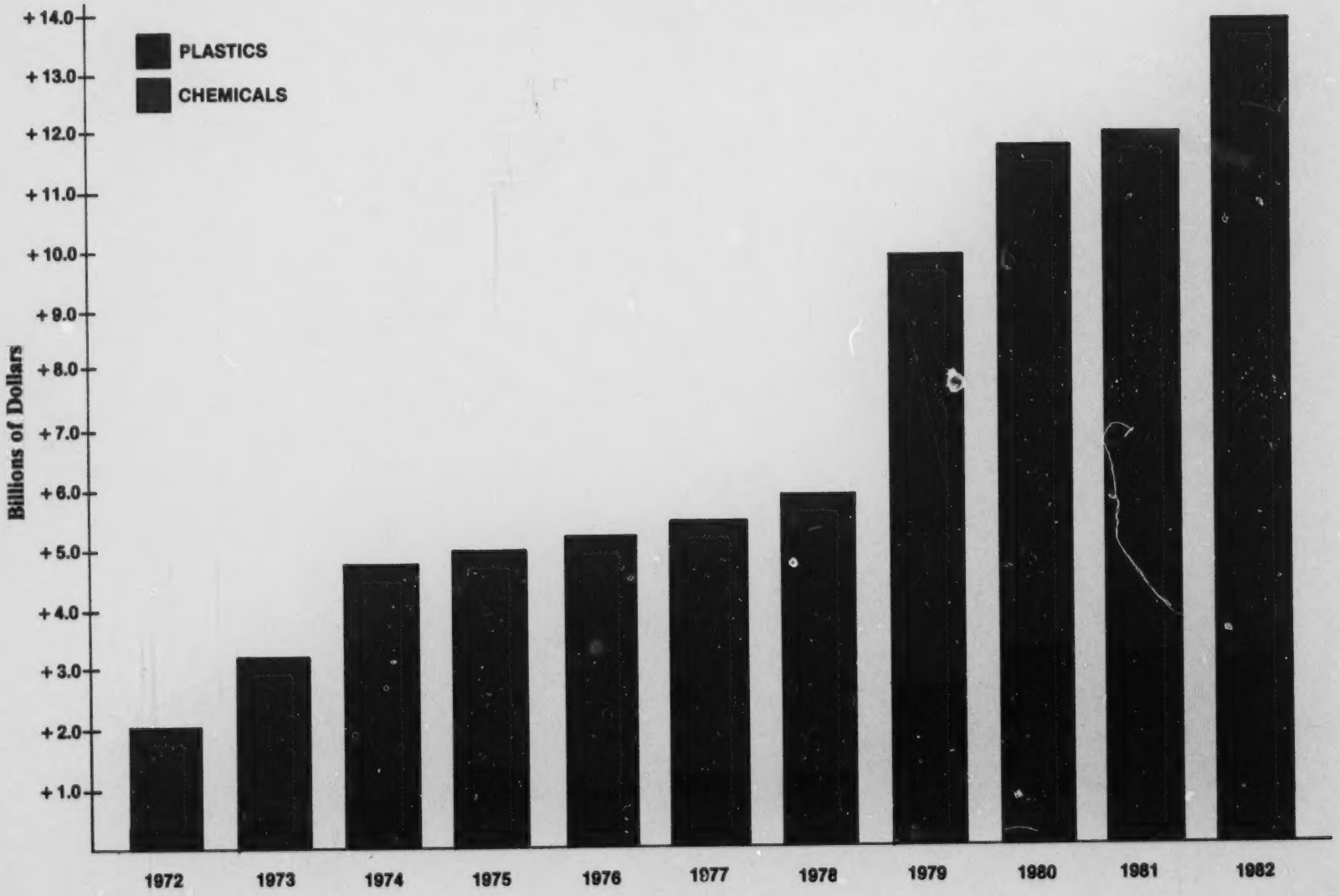
Source: U.S. Dept. of Commerce; FT 135(U.S. Imports), FT 410(U.S. Exports)

U.S. BALANCE OF TRADE—1982



Source: Department of Commerce
*Chemicals exclude plastics

PLASTICS & CHEMICALS BALANCE OF TRADE 1972-1982



PRODUCER PRICE INDEXES

[1967 = 100]

COMMODITY GROUP

YEAR	NON-METALLIC MINERAL PRODUCTS	METALS & METAL PRODUCTS	INDUSTRIAL COMMODITIES	CHEMICALS & ALLIED PRODUCTS	PLASTICS RESINS & MATERIALS
1968	103.7	102.6	102.5	99.8	91.9
1969	107.7	108.5	106.0	99.9	90.4
1970	113.3	116.7	110.0	102.2	90.7
1971	122.4	119.0	114.0	104.2	88.9
1972	126.1	123.5	117.9	104.2	88.7
1973	130.2	132.8	125.9	110.0	92.1
1974	153.2	171.9	153.8	146.8	143.8
1975	174.0	185.6	171.5	181.3	180.9
1976	186.3	195.9	182.4	187.2	194.0
1977	200.5	209.0	195.1	192.8	197.5
1978	228.8	227.1	209.4	198.8	199.9
1979	248.6	259.3	236.5	222.3	235.9
1980	282.9	286.4	274.3	260.3	279.5
1981	309.5	300.4	304.1	287.7	289.2
1982	318.6	302.0	312.4	292.3	283.3

WHAT IS SIC?

The Standard Industrial Classification System (SIC) classifies all manufacturing and services produced in the U.S. It starts with the broadest industrial aggregations; then, by a series of subdivisions, it identifies more finely detailed classes or groupings right down to the individual product level. Thus at the first level there is the manufacturing sector. At the next level of detail, manufacturing is divided into twenty 2-digit *Major Groups,* such as SIC 28, CHEMICALS. Those are subdivided into 3-digit *Industry Groups,* of which there are 143, such as 282, plastics and synthetic fibers.

The next level is made up of 4-digit *Specific Industries,* of which there are 457, including SIC 2821, plastics resins and materials. This level of detail is the one used in the "Survey of Industrial Purchasing Power."

A complete list of industries, and their definitions, appears in the "Standard Industrial Classification Manual," available from the U.S. Government Printing Office, Washington, D.C. 20402; price $6.75.

The basic reporting unit in the SIC is the individual establishment, such as a factory, plant or mill, engaged primarily in manufacturing products and thus distinguished from a central administrative office or other auxiliary units. Also, an establishment is not necessarily identical with the business firm, which may consist of more than one such facility.

1982

SIC	Industry	Number of Plants		Shipments ($Mil.)
		Total Plants	Employment	
SIC 28 Chemicals				
2812	Alkalies & chlorine	73	20,135	1,287
2813	Industrial gases	356	17,860	1,459
2819	Industrial inorganic chemicals n.e.c.	599	98,503	11,487
2821	**Plastics materials & synthetic resins**	484	89,330	16,487
2822	Synthetic rubber	48	22,054	2,942
2823	Cellulosic man-made fibers	11	20,463	1,501
2824	Noncellulosic synthetic organic fibers	58	62,959	9,433
2833	Medicinals & botanicals	114	23,011	3,130
2834	Pharmaceutical preparations	464	125,453	17,426
2841	Soap & other detergents	274	35,992	9,220
2842	Polishes & sanitation goods	523	40,968	4,607
2844	Toilet preparations	264	55,843	8,773
2851	Paints & allied products	886	70,983	9,227
2865	Cyclic crudes & intermediates	192	28,823	7,196
2869	Industrial organic chemicals n.e.c.	526	110,692	32,123
2874	Phosphatic fertilizers	87	16,798	5,015
2891	Adhesives & sealants	309	26,722	2,606
2892	Explosives	67	12,392	1,025
2893	Printing ink	211	12,310	1,422
2899	Chemical preparations n.e.c.	763	56,101	6,252
SIC 30 Rubber & misc. plastics				
3011	Tires & inner tubes	123	84,419	7,860
3021	Rubber & plastic footwear	41	17,926	527
3041	Rubber & plastic hose & belting	170	31,271	1,733
3069	Fabricated rubber products n.e.c.	890	121,140	4,810
3079	**Miscellaneous plastics products**	4,896	434,641	27,288

Source: *Sales & Marketing Management's 1983 Survey of Industrial Purchasing Power, U.S. Dept. of Commerce.*

PROFILE OF 50 BIGGEST MANUFACTURING INDUSTRIES

1982 Rank	SIC	Industry	1982 Shipments ($ Mil.)	Total Plants	Shipments Per Plant ($000)	% Shipments Large Plants
1.	2911	Petroleum refining	$234,381	352	$665,855	91%
2.	3711	Motor vehicles & car bodies	103,547	179	578,477	99
3.	3312	Blast furnaces & steel mills	64,547	357	180,805	98
4.	2011	Meat packing plants	52,354	1,002	52,249	80
5.	3714	Motor vehicle parts & accessories	51,387	1,249	41,142	93
6.	2869	Industrial organic chemicals, n.e.c.	41,577	525	79,194	87
7.	3573	Electronic computing equipment	36,145	1,214	29,773	90
8.	3721	Aircraft	32,756	123	266,307	99
9.	3079	**Misc. plastics products**	31,587	4,892	6,457	65
10.	3662	Radio & tv communication equipment	27,462	1,215	22,602	89
11.	3531	Construction machinery	23,035	516	44,641	91
12.	2711	Newspapers	22,330	2,458	9,085	75
13.	2821	**Plastics materials & resins**	20,702	484	42,772	85
14.	2621	Paper mills, except building paper	20,027	343	58,388	97
15.	2026	Fluid milk	19,560	972	20,123	69
16.	3861	Photographic equip. & supplies	18,451	397	46,475	86
17.	2752	Commercial printing, lithographic	16,893	1,904	8,873	52
18.	2086	Bottled & canned soft drinks	16,387	1,607	10,197	56
19.	2834	Pharmaceutical preparations	15,839	464	34,135	92
20.	3585	Refrigeration & heating equipment	15,736	551	28,560	89
21.	3599	Nonelectrical machinery, n.e.c.	15,661	3,259	4,806	33
22.	3523	Farm machinery & equipment	15,551	873	17,814	80
23.	3731	Ship building & repairing	15,019	355	42,306	95
24.	3519	Internal combustion engines, n.e.c.	14,913	137	108,853	96
25.	2819	Industrial inorganic chemicals, n.e.c.	14,877	599	24,836	84
26.	3724	Aircraft engines & engine parts	14,710	163	90,247	95
27.	2421	Sawmills & planing mills, general	14,506	1,957	7,412	57
28.	3661	Telephone & telegraphic apparatus	14,195	228	62,261	97
29.	3674	Semiconductors & related devices	13,633	315	43,279	94
30.	2653	Corrugated & solid fiber boxes	13,056	1,100	11,869	73
31.	3679	Electronic components, n.e.c.	13,016	1,698	7,666	81
32.	2013	Sausages & other prepared meats	12,737	760	16,759	70
33.	2824	Organic fibers, noncellulosic	11,844	58	204,214	99
34.	2051	Bread, cake & related products	11,759	1,376	8,546	82
35.	3443	Fabricated plate work, boiler shops	11,645	1,262	9,227	71
36.	2851	Paints & allied products	11,580	886	13,070	61
37.	2075	Soybean oil mills	11,371	80	142,136	51
38.	3728	Aircraft equipment, n.e.c.	11,282	606	18,616	87
39.	3533	Oil-field machinery	11,222	409	27,437	81
40.	2721	Periodicals	11,152	929	12,005	67
41.	2082	Malt beverages	11,051	83	133,147	98
42.	2048	Prepared feeds, n.e.c.	10,840	1,029	10,534	32
43.	2631	Paperboard mills	10,788	203	53,140	93
44.	2022	Cheese, natural & processed	10,493	327	32,087	65
45.	3651	Radio & TV receiving sets	10,418	281	37,074	93
46.	3441	Fabricated structural metal	10,222	1,715	5,960	55
47.	3465	Automotive stamping	10,145	203	49,976	95
48.	3761	Guided missiles & space vehicles	10,109	72	140,401	98
49.	2016	Poultry-dressing plants	9,997	297	33,660	95
50.	3411	Metal cans	9,906	336	29,482	90
		50-industry total	$1,232,398	42,400	$29,066	86%

n.e.c.: not elsewhere classified.

Definitions: **Shipments:** Output of all manufacturing plants. **No. of Plants:** Manufacturing establishments with 20 or more employees.

Average Shipments per plant: A mathematical average, computed by dividing number of plants into total shipments. % Large Plants: Share of shipments accounted for by plants with 100 or more employees.

Sources: *Sales & Marketing Management's 1983 Survey of Industrial Purchasing Power.* U.S. Commerce Dept., *U.S. Industrial Outlook 1983.*

INDUSTRY FINANCIAL PERFORMANCE — 1982

RETURN ON SALES
THE INDUSTRY MEDIANS

	1982	1981
Pharmaceuticals	9.9%	9.1%
Publishing, printing	6.5	7.1
Measuring, scientific, photographic equipment	5.9	6.9
Office equipment (includes computers)	5.9	6.1
Beverages	5.4	5.5
Soaps, cosmetics	5.2	5.0
Electronics, appliances	4.5	4.4
Chemicals	4.0	5.4
Petroleum refining	4.0	4.4
Metal products	3.8	4.4
Apparel	3.4	3.4
Food	3.3	3.3
Paper, fiber, and wood products	3.2	5.0
Industrial and farm equipment	3.2	4.6
Mining, crude-oil production	3.0	11.7
Shipbuilding, railroad and transportation equipment	2.8	4.5
Aerospace	2.8	4.0
Textiles, vinyl flooring	2.1	2.9
Motor vehicles	1.7	2.6
Glass, concrete, abrasives, gypsum	1.5	3.1
Rubber, plastic products	0.9	3.0
Metal manufacturing	0.0	4.4
All Industries	3.6	4.6
Custom Processors	2.6	
Proprietary Processors	2.9	
All Processors	2.8	

CHANGES IN SALES
THE INDUSTRY MEDIANS

INCREASES	
Office equipment (includes computers)	18.6 %
Publishing, printing	10.0
Beverages	6.7
Soaps, cosmetics	6.1
Pharmaceuticals	3.8
Apparel	3.0
Food	2.0
Electronics, appliances	0.7
DECREASES	
Metal manufacturing	21.6 %
Rubber, plastic products	10.5
Industrial and farm equipment	10.2
Textiles, vinyl flooring	9.1
Shipbuilding, railroad and transportation equipment	7.9
Motor vehicles	6.9
Chemicals	6.5
Glass, concrete, abrasives, gypsum	5.3
Paper, fiber, and wood products	3.1
Petroleum refining	3.0
Measuring, scientific, photographic equipment	2.7
Metal products	2.3
Aerospace	1.8
Mining, crude-oil production	0.8
Custom Processors	12.0 (1981)
Proprietary Processors	12.7 (1981)
All Processors	12.3 (1981)

SALES PER EMPLOYEE
THE INDUSTRY MEDIANS

Petroleum refining	$515,722
Mining, crude-oil production	195,915
Food	123,834
Beverages	120,016
Chemicals	114,823
Soaps, cosmetics	111,853
Metal manufacturing	101,773
Paper, fiber, and wood products	100,849
Rubber, plastic products	94,578
Glass, concrete, abrasives, gypsum	84,385
Motor vehicles	83,550
Metal products	83,413
Pharmaceuticals	83,394
Industrial and farm equipment	82,873
Publishing, printing	82,312
Shipbuilding, railroad and transportation equipment	78,220
Aerospace	76,824
Measuring, scientific, photographic equipment	68,996
Electronics, appliances	62,959
Office equipment (includes computers)	62,679
Textiles, vinyl flooring	53,665
Apparel	47,551
All Industries	90,837
Custom Processors	54,475 (1981)
Proprietary Processors	67,481 (1981)
All Processors	56,889 (1981)

TOTAL RETURN TO INVESTORS
THE INDUSTRY MEDIANS

Rubber, plastic products	71.02%
Textiles, vinyl flooring	54.37
Publishing, printing	48.88
Apparel	47.16
Beverages	45.50
Soaps, cosmetics	42.64
Food	39.72
Motor vehicles	38.98
Electronics, appliances	37.66
Pharmaceutcals	32.82
Aerospace	30.70
Office equipment (includes computers)	28.82
Paper, fiber, and wood products	28.62
Glass, concrete, abrasives, gypsum	25.91
Shipbuilding, railroad and transportation equipment	11.15
Chemicals	9.53
Metal products	9.10
Measuring, scientific, photographic equipment	6.81
Industrial and farm equipment	– 1.19
Petroleum refining	– 10.79
Metal manufacturing	– 11.60
Mining, crude-oil production	– 22.63
All Industries	21.22
Custom Processors	11.0 (1981)
Proprietary Processors	9.5 (1981)
All Processors	10.4 (1981)

Source: "The Fortune Directory of the 500 Largest U.S. Industrial Corporations"
SPI Financial Management Committee, Financial and Operating Ratios Survey

TOTAL RETURN TO INVESTORS, 1972-82
THE INDUSTRY MEDIANS

Aerospace	17.75%
Publishing, printing	14.17
Paper, fiber and wood products	11.01
Metal manufacturing	10.37
Petroleum refining	10.30
Apparel	10.20
Chemicals	9.92
Mining, crude-oil production	9.80
Food	9.75
Shipbuilding, railroad and transportation equipment	9.74
Textiles, vinyl flooring	9.68
Office equipment (includes computers)	9.12
Metal products	8.54
Electronics, appliances	8.05
Rubber, plastic products	7.92
Industrial and farm equipment	7.82
Glass, concrete, abrasives, gypsum	6.59
Motor vehicles	5.44
Beverages	5.00
Pharmaceuticals	3.03
Measuring, scientific, photographic equipment	2.13
Soaps, cosmetics	— .39
All Industries	9.34
Custom Processors	— 6.0 (1971-81)
Proprietary Processors	— 26.0 (1971-81)
All Processors	— 16.0 (1971-81)

CHANGES IN PROFITS
THE INDUSTRY MEDIANS

	INCREASES
Pharmaceuticals	13.3%
Apparel	12.5
Publishing, printing	10.4
Soaps, cosmetics	9.1
Office equipment (includes computers)	8.9
Beverages	8.5
Food	7.1
Textiles, vinyl flooring	4.9
Electronics, appliances	1.1

	DECREASES
Metal manufacturing	100.0%
Motor vehicles	55.4
Rubber, plastic products	50.4
Mining, crude-oil production	47.5
Glass, concrete, abrasives, gypsum	40.8
Paper, fiber, and wood products	39.1
Industrial and farm equipment	37.3
Aerospace	30.9
Chemicals	30.8
Shipbuilding, railroad and transportation equipment	20.3
Metal products	16.7
Petroleum refining	14.9
Measuring, scientific, photographic equipment	7.1
Custom Processors	+ 8.3 (1981)
Proprietary Processors	+ 38.0 (1981)
All Processors	+ 23.8 (1981)

ASSETS PER EMPLOYEE
THE INDUSTRY MEDIANS

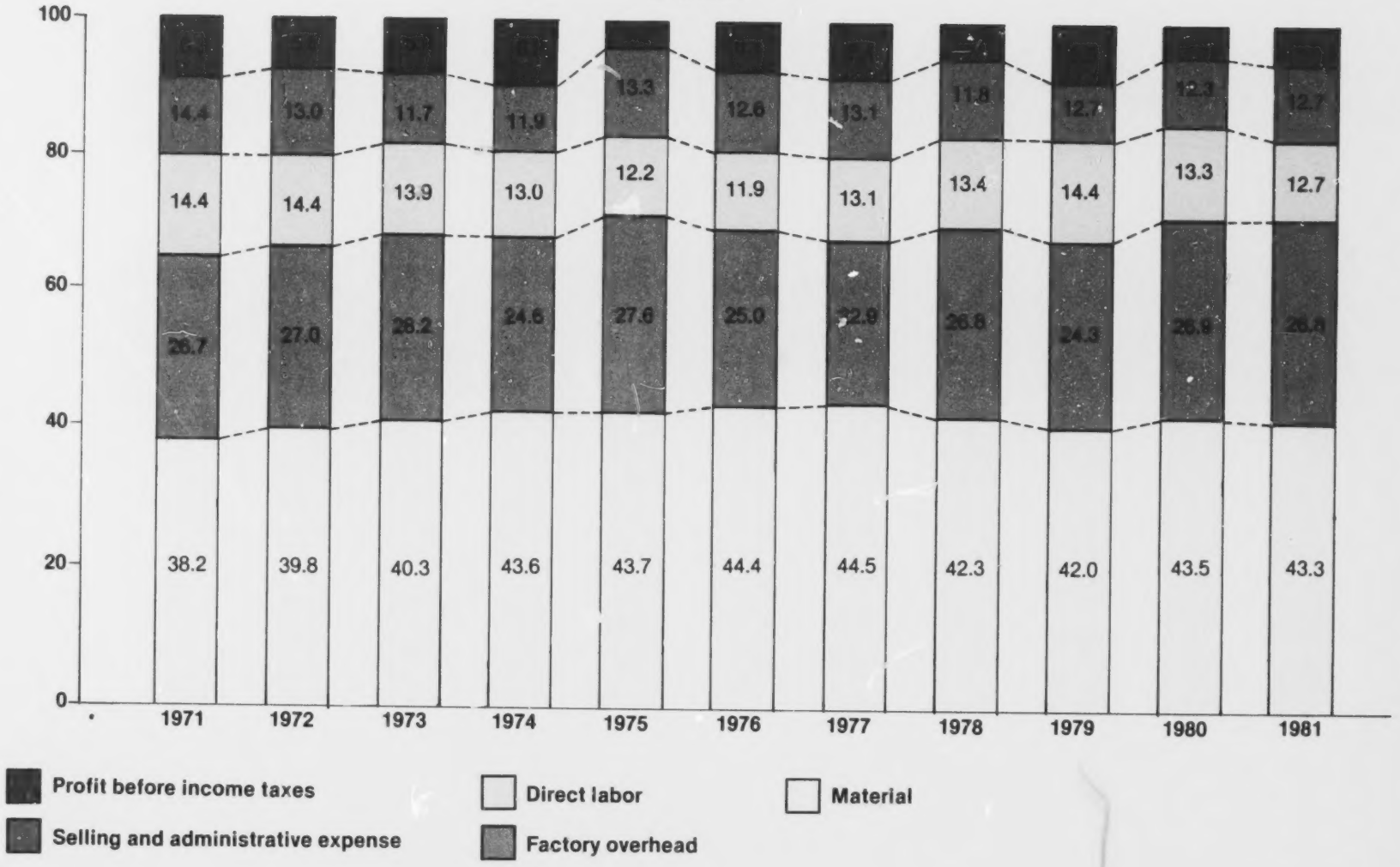
Petroleum refining	$392,178
Mining, crude-oil production	334,749
Chemicals	106,699
Metal manufacturing	100,093
Paper, fiber, and wood products	96,643
Beverages	92,971
Pharmaceuticals	79,602
Publishing, printing	72,936
Glass, concrete, abrasives, gypsum	72,321
Soaps, cosmetics	71,238
Industrial and farm equipment	65,729
Motor vehicles	62,838
Office equipment (includes computers)	62,517
Food	59,077
Metal products	57,894
Aerospace	53,236
Rubber, plastic products	52,987
Measuring, scientific, photographic equipment	51,730
Electronics, appliances	48,753
Shipbuilding, railroad and transportation equipment	45,119
Textiles, vinyl flooring	33,897
Apparel	24,818
All Industries	66,797
Custom Processors	26,755 (1981)
Proprietary Processors	36,009 (1981)
All Processors	28,965 (1981)

RETURN ON STOCKHOLDERS' EQUITY
THE INDUSTRY MEDIANS

	1981	1980
Pharmaceuticals	16.9	18.0
Beverages	16.7	19.2
Soaps, cosmetics	16.0	16.8
Publishing, printing	15.5	16.4
Food	15.3	14.4
Measuring, scientific, photographic equipment	12.8	15.6
Petroleum refining	12.5	16.4
Office equipment (includes computers)	12.4	13.3
Apparel	12.3	16.2
Electronics, appliances	11.7	14.3
Metal products	11.7	14.1
Aerospace	11.7	15.0
Mining, crude-oil production	9.0	17.6
Chemicals	8.6	13.5
Shipbuilding, railroad and transportation equipment	8.6	14.4
Industrial and farm equipment	8.5	13.9
Paper, fiber, and wood products	8.0	12.0
Textiles, vinyl flooring	6.3	7.8
Motor vehicles	5.1	7.6
Glass, concrete, abrasives, gypsum	4.3	9.6
Rubber, plastic products	1.9	10.4
Metal manufacturing	0.0	12.4
All Industries	10.9	13.8
Custom Processors	11.9	
Proprietary Processors	12.0	
All Processors	11.9	

Source: "The Fortune Directory of the 500 Largest U.S. Industrial Corporations"
SPI Financial Management Committee, Financial and Operating Ratios Survey

TREND IN DISTRIBUTION OF SALES DOLLAR
PLASTICS PROCESSING COMPANIES
1971-1981



SALES OF MAJOR U.S. PLASTICS PRODUCING COMPANIES
(rounded to nearest $25 million)

Company[3]	Plastics Sales[1]		Chemicals Sales[2]		Total Sales	
	1982	1981	1982	1981	1982	1981
1 Du Pont	3,050	3,325	6,825	7,250	33,325	33,000
2 Dow Chemical	2,250	3,225	7,150	7,650	10,625	11,875
3 Dart & Kraft	1,400	1,750	1,500	1,825	9,975	10,200
4 Exxon	1,200	1,300	7,250	8,450	102,050	113,200
5 Union Carbide	1,050	1,225	3,275	3,800	9,050	10,150
6 Monsanto	775	1,050	2,600	3,050	6,325	6,950
7 B.F. Goodrich	750	675	1,025	1,050	3,000	3,175
8 Hercules	700	750	2,050	2,275	2,475	2,725
8 Standard Oil (Indiana)	700	725	2,775	3,100	29,775	31,725
10 Shell Oil	650	700	3,000	3,475	20,225	21,750
10 Mobil Oil	650	675	2,250	2,450	64,150	68,575
12 Celanese	525	650	675	825	3,050	3,750
12 Reichhold Chemicals	525	575	725	825	825	950
14 Gulf Oil	500	550	1,975	2,400	30,625	30,450
14 Phillips Petroleum	500	475	2,350	2,475	15,700	15,975
16 Atlantic Richfield	425	500	2,250	2,750	27,000	28,200
17 Occidental Petroleum	400	500	1,250	1,425	18,525	15,350
17 Ethyl	400	425	1,400	1,525	1,625	1,750
17 General Electric	400	425	400	425	26,500	27,250
20 Borg Warner	350	375	600	650	3,200	3,125
20 Rohm and Haas	350	375	1,725	1,750	1,825	1,875
22 W.R. Grace	325	350	2,650	2,700	6,125	6,525
23 Goodyear Tire & Rubber	300	325	925	1,000	8,700	9,150
24 Eastman Kodak	250	250	2,150	2,350	10,825	10,325
24 U.S. Steel	250	325	1,100	1,500	18,900	13,950
26 National Distillers	225	250	675	750	1,825	2,025
27 Georgia Pacific	200	225	625	750	5,400	5,425
28 Allied	175	200	2,400	2,800	6,175	6,400
29 Tenneco	150	175	1,700	1,875	14,975	15,075
29 Certain Teed	150	175	150	175	825	900
31 Borden	125	175	1,225	1,425	4,100	4,425

Note: There are several domestic and foreign-based companies which could be listed above had data been available such as Mobay, American Hoechst, Ciba-Geigy, Soltex Polymer, et al.

[1] Includes fabricated plastics products.

[2] Includes plastics.

[3] Ranked by plastics sales in 1982.

Source: Company annual reports, industry estimates.

PLASTIC PROCESSING INDUSTRY BY SALES GROUP—1981

Operating Statements	SALES LESS THAN $5 MILLION		
	Less Profitable	Median	More Profitable
Sales	100.0	100.0	100.0
Less Adjustments & Allowances	2.1	1.6	1.0
Net Sales	97.9	98.4	99.0
Direct Materials	38.5	39.6	39.9
Direct Labor	13.9	13.0	12.2
Indirect Labor	6.8	6.2	5.6
Utilities	4.2	3.4	2.6
Depreciation	3.1	3.1	3.0
Other Mfg. Expense	12.5	12.4	12.3
Net on Tool Transactions	0.5	0.8	1.4
Selling Expenses	5.5	5.0	4.4
Administrative Expense	10.7	9.8	8.9
Operating Earnings	2.2	5.1	8.7
Other Income or (Expense)	1.6	0.9	0.3
Profit Before Income Taxes	0.6	4.2	8.4
Income Taxes	0.0	1.4	2.2
PROFIT AFTER INCOME TAXES	0.6	2.8	6.2
Sales as Percentage of Total Assets	190.9%	196.1%	201.2%
Balance Sheets			
Cash	3.7	6.1	8.5
Accounts & Notes Receivable	23.4	24.7	27.0
Inventory	18.3	18.0	16.7
Other Current Assets	2.0	2.6	3.1
CURRENT ASSETS	47.4	51.4	55.3
Land & Buildings, at Cost	28.8	23.2	17.9
Depreciation Reserve	7.0	5.5	4.1
Machinery & Equipment, at Cost	59.7	55.0	50.2
Depreciation Reserve	32.3	27.6	23.0
Other Long-Term Assets	3.4	3.5	3.7
TOTAL ASSETS	100.0	100.0	100.0
Current Portion of Term Debt	4.9	4.0	3.0
Notes Payable	21.1	15.7	10.3
Accounts Payable, Trade	14.4	11.6	8.8
Other Payables & Accruals	7.3	8.4	9.5
CURRENT LIABILITIES	47.7	39.7	31.6
Other Long-Term Debt	6.0	5.3	4.7
TOTAL LIABILITIES	53.7	45.0	36.3
EQUITY (NET WORTH)	46.3	55.0	63.7
Statistical Data			
Percent Change in Sales, '82 vs. '81	(22.2%)	1.9%	7.7%
Cost of Sales/Inventory	43.1	42.2	39.6
Average Collection Period	44.7	46.0	49.0
Profit Before Income Taxes/Assets	1.1%	8.2%	16.9%
Net Income/Equity	2.5%	10.0%	19.6%

Source: SPI Financial and Operating Ratios Survey No. 21—1982

PLASTIC PROCESSING INDUSTRY BY SALES GROUP—1981

Operating Statements	SALES $5-$10 MILLION		
	Less Profitable	Median	More Profitable
Sales	100.0	100.0	100.0
Less Adjustments & Allowances	1.5	1.4	1.3
Net Sales	98.5	98.6	98.7
Direct Materials	47.7	46.5	45.5
Direct Labor	11.2	11.2	11.2
Indirect Labor	4.6	6.0	7.4
Utilities	3.1	3.0	2.8
Depreciation	3.0	2.8	2.6
Other Mfg. Expense	12.1	11.2	10.6
Net on Tool Transactions	0.1	(0.1)	(0.3)
Selling Expenses	4.5	4.2	3.6
Administrative Expense	9.5	8.2	6.9
Operating Earnings	2.7	5.6	8.4
Misc. Income or (Expense)	1.1	0.8	0.5
Profit Before Income Taxes	1.6	4.8	7.9
Income Taxes	0.3	1.7	2.9
PROFIT AFTER INCOME TAXES	1.3	3.1	5.0
Sales as Percentage of Total Assets	168.9%	170.1%	171.2%
Balance Sheets			
Cash	2.3	3.2	4.0
Accounts & Notes Receivable	23.7	24.1	26.2
Inventory	21.6	21.5	21.4
Other Current Assets	2.2	1.8	1.3
CURRENT ASSETS	49.8	50.6	52.9
Land & Buildings, at Cost	26.2	26.4	26.7
Depreciation Reserve	5.3	6.5	7.7
Machinery & Equipment, at Cost	57.3	59.9	60.7
Depreciation Reserve	31.0	33.3	35.5
Other Long-Term Assets	3.0	2.9	2.9
TOTAL ASSETS	100.0	100.0	100.0
Current Portion of Term Debt	4.9	4.6	4.2
Notes Payable	22.1	16.6	9.6
Accounts Payable, Trade	13.7	11.3	8.9
Other Payables & Accruals	6.6	7.1	7.4
CURRENT LIABILITIES	47.3	39.6	30.1
Other Long-Term Debt	20.4	12.0	5.5
TOTAL LIABILITIES	67.7	51.6	35.6
EQUITY (NET WORTH)	32.3	48.4	64.4
Statistical Data			
Percent Change in Sales, '82 vs. '81	(1.7%)	(3.0%)	(4.2%)
Cost of Sales/Inventory	56.1	56.1	56.1
Average Collection Period	51.2	51.7	55.9
Profit Before Income Taxes/Assets	2.7%	8.2%	13.5%
Net Income/Equity	6.8%	16.9%	21.0%

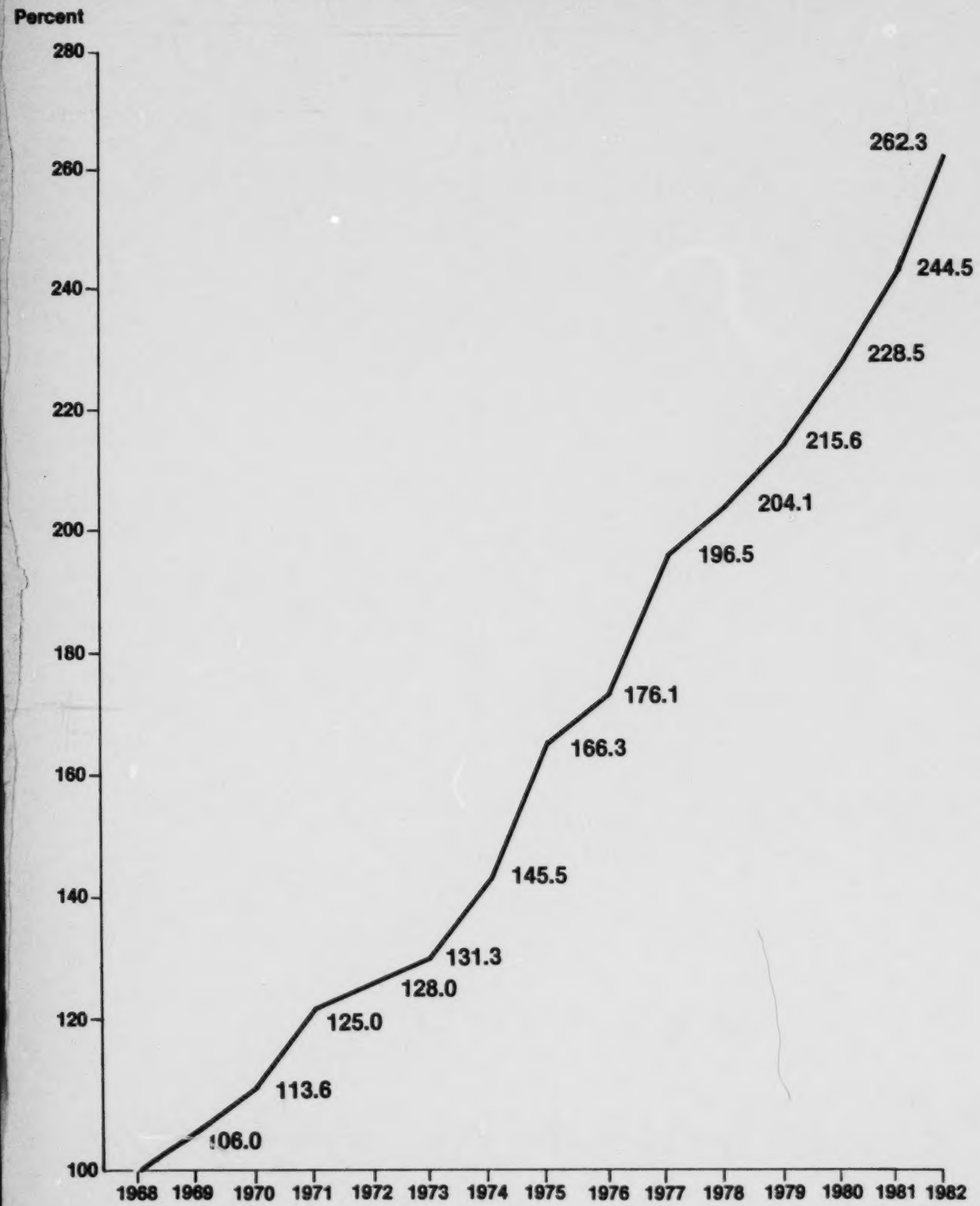
Source: SPI Financial and Operating Ratios Survey No. 21—1982

PLASTICS PROCESSING INDUSTRY BY SALES GROUP—1981

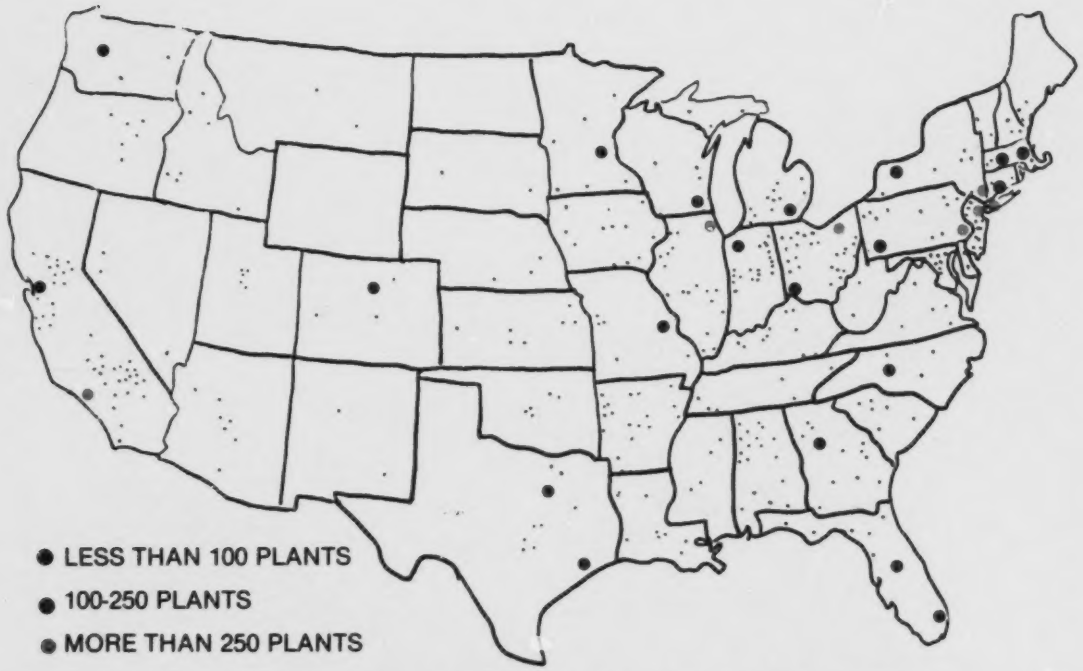
Operating Statements	SALES $10 MILLION AND OVER		
	Less Profitable	Median	More Profitable
Sales	100.0	100.0	100.0
Less Adjustments & Allowances	0.6	0.5	0.3
Net Sales	99.4	99.5	99.7
Direct Materials	46.8	46.2	45.6
Direct Labor	13.1	12.0	10.9
Indirect Labor	12.5	10.8	9.3
Utilities	3.6	3.2	2.7
Depreciation	4.0	3.5	2.9
Other Mfg. Expense	8.0	7.7	7.5
Net on Tool Transactions	(0.2)	(0.2)	(0.2)
Selling Expenses	4.1	5.0	5.7
Administrative Expense	8.7	8.1	7.3
Operating Earnings	(1.2)	3.2	8.0
Misc. Income or (Expense)	0.9	0.9	0.7
Profit Before Income Taxes	(2.1)	2.3	7.3
Income Taxes	(1.1)	0.9	2.4
PROFIT AFTER INCOME TAXES	(1.0)	1.4	4.9
Sales as Percentage of Total Assets	174.0%	173.7%	173.3%
Balance Sheets			
Cash	1.3	1.6	1.9
Accounts & Notes Receivable	22.4	22.5	22.8
Inventory	14.9	16.1	18.1
Other Current Assets	4.2	3.1	2.0
CURRENT ASSETS	42.8	43.8	44.8
Land & Buildings, at Cost	28.2	26.1	22.8
Depreciation Reserve	7.5	6.5	5.4
Machinery & Equipment, at Cost	65.8	59.3	55.2
Depreciation Reserve	32.1	26.8	24.0
Other Long-Term Assets	2.8	4.6	6.6
TOTAL ASSETS	100.0	100.0	100.0
Current Portion of Term Debt	1.6	2.3	3.0
Notes Payable	4.8	6.1	6.5
Accounts Payable, Trade	14.0	11.4	9.1
Other Payables & Accruals	5.7	7.5	9.6
CURRENT LIABILITIES	26.1	27.3	28.2
Other Long-Term Debt	17.5	14.3	9.9
TOTAL LIABILITIES	43.6	41.6	38.1
EQUITY (NET WORTH)	56.4	58.4	61.9
Statistical Data			
Percent Change in Sales, '82 vs. '81	(4.9%)	(3.6%)	0.6%
Cost of Sales/Inventory	37.4	40.0	44.8
Average Collection Period	49.9	46.9	44.7
Profit Before Income Taxes/Assets	(3.4%)	4.2%	13.6%
Net Income/Equity	(2.9%)	4.2%	14.7%

Source: SPI Financial and Operating Ratios Survey No. 21—1982

PLASTICS PROCESSING COMPANIES
TREND IN STRAIGHT-TIME HOURLY WAGES
1968-1982 (1968 = 100)



U.S. PLASTICS RESIN PLANT LOCATIONS



U.S. PLASTICS PROCESSING PLANT LOCATIONS

ENERGY FEEDSTOCKS, & ADDITIVES

PLASTICS: THE ENERGY SAVER[1]

In a study prepared by Franklin Associates, Ltd. the use of plastics products and equivalent products made from non-plastics alternative materials was analyzed in terms of energy impact. The 1981 study concluded that energy consumption would increase substantially if plastics products were not available.

The results of the study are presented in terms of net energy savings. These savings are the difference between the quantity of energy consumed in the manufacture of plastics products and that of non-plastics alternative products. Energy values are given in British Thermal Units (Btu) and because of the large quantities of materials and related consumption, all energy is stated in trillion (10^{12}) Btu. For comparison, the energy content of a barrel of oil is 5.8 million Btu and of one ton of coal is 29.2 million Btu. The following summary findings are noted:

- For most end-uses, plastics products require less energy to manufacture and use than equivalent products made of alternative materials.

- In the analyses of specific resins or groups of resins, the sum of the energy required for the plastics products was always less than that required for the products made of alternative materials. In other words, when entire resins or groups of similar resins are examined for all end-uses, the energy requirements for using those resins are less than the requirements for using alternative non-plastics products.

- In 1978, if the plastics products analyzed in this study had been completely replaced by the selected non-plastics alternative products, total energy consumption would have increased by 834.2 trillion Btu.

- Although market conditions and manufacturing technologies continue to change, it is reasonable to expect the same relative energy savings from the use of plastics over non-plastics materials in future years.

- The total energy savings determined in this study are associated with the manufacture and use of 82 percent of the plastics consumed in the U.S. in 1978. It is believed that the plastics resins not included in this study would show energy savings through the use of plastics. However, the results of the study should not be extrapolated to total resin use.

- Plastics products require less energy than non-plastics products in 204 of the 264 markets studied. These 204 markets account for 90 percent of the resins analyzed. Of the 55 markets showing higher energy consumption for the plastics products, 12 showed a difference of less than 10 percent.

- To illustrate the magnitude of energy savings through plastics, 834 trillion Btu is equivalent to:

  - 75,766 million kilowatt-hours

  or

  - 28.7 million tons of coal

  or

  - 142 million barrels of oil

  or

  - 2,484 million gallons of gasoline

[1]Both the Summary and complete Franklin study are available from the Literature Department, SPI, 355 Lexington Ave., N.Y., N.Y. 10017.

Energy savings by resin, 1978

Resin	Total Energy Savings Trillion (10^{12}) Btu
High density polyethylene	159.5
Polystyrene	151.4
PVC	139.9
Polypropylene	123.0
Low density polyethylene	113.9
Polyester	86.6
ABS and SAN	49.8
Nylon	5.4
Phenolics, Urea, and Melamine	4.7
Total resin studied	834.2[1]

[1] With energy savings from wood-derived fuel omitted this figure would be 733.1 trillion Btu.

Summary of energy use by source, 1978

Comparative energy requirements associated with plastics products
Produced from twelve major plastics and
Equivalent products made of alternative materials

Trillion (10^{12}) Btu

Energy Consumption[1]

	Plastics Products[2]	Non-Plastics Alternatives	Energy Savings With Plastics (Net Difference)
Hydrocarbons	970.5	1,124.3	153.8[3]
Coal	153.7	700.7	547.0
Hydropower	13.2	30.3	17.1
Nuclear	30.0	45.2	15.2
Wood	13.9	115.0	101.1
Total	1,181.3	2,015.5	834.2 [4,5]

[1] Energy consumption represents the total energy required to manufacture the products produced from the resin included in the analysis and the non-plastics alternatives to those products.

[2] No realistic plastics alternatives were identified for 10.5 percent of the resin included in the comparative energy analysis. The energy required to produce these products is not included here.

[3] Includes an estimated savings of 186.4 trillion Btu for natural gas and an increased consumption of 32.6 trillion Btu for petroleum.

[4] Approximately 5.1 percent of the total estimated savings are calculated using service life analyses for 11 specific markets. These analyses account for the energy used in the service life of the products in addition to the energy of manufacture.

[5] With wood-derived fuel omitted the net difference would be 733.1 trillion Btu.

ENERGY SAVING THROUGH PLASTICS BY END USE

IN FURNITURE

In 1980, approximately 125 million pounds of polystyrene plastics were utilized just to make furniture components. Included were such items as drawer fronts, ornate "woodwork," small tables, etc. Plastics replaced other materials—steel, aluminum, wood—for these purposes.

It has been estimated that it would take 560 million pounds of these alternate materials to do the jobs performed by polystyrene plastics in furniture applications.

It would take 15.7 trillion BTU to produce those 560 million pounds of alternate materials and only 5.7 trillion BTU to make the volume of polystyrene plastics necessary for the same use. This represents a savings in our nation's energy resources of 10 trillion BTU—the equivalent of 1.7 million barrels of crude petroleum.

IN THE KITCHEN

For example, 279 million pounds of low density polyethylene film were used to package baked goods in 1980, primarily bread and rolls plus significant quantities of cookies and crackers. Major materials replaced by this film include wax paper, paperboard and aluminum foil.

A comparison based on estimated market shares and relative weights of the substitute materials showed that it would require 619 million pounds of the alternate materials to do the job handled by just 269 million pounds of polyethylene.

The energy required to manufacture the alternate materials would be 24.8 trillion BTU versus only 13.3 trillion BTU for the polyethylene film. This net savings of 11.5 trillion BTU is equivalent to the energy of 2 million barrels of crude oil.

IN AUTOMOBILES

In an analysis of eleven major applications involving five different plastics material families, it was found that 825 million pounds of plastics for these applications replaced 2.2 billion pounds of non-plastics materials. The total energy savings in manufacturing these plastics components were 32.5 trillion BTU instead of the 71.8 BTU of energy that would have been required to manufacture the non-plastics products; 55 percent reduction in manufacturing energy requirements.

The energy savings of 32.5 trillion BTU in these applications is equivalent to 5.5 million barrels of petroleum or 97 million gallons of gasoline, the amount needed to drive approximately 300,000 automobiles each an average of 10,000 miles for one year.

IN CONSTRUCTION

Remarkable savings in energy consumption were achieved through the use of plastics materials in construction in the year noted. For instance, some 335 million pounds of PVC plastics material were used to fabricate such items as siding, weather stripping, windows and exterior house fixtures. These replaced products made of traditional materials—wood, metal, glass and rubber.

Calculations show that it would have required 636 million pounds of those non-plastics materials to replace the products made of PVC. To manufacture those items with non-plastics material would require 25-75 trillion BTU. The energy to produce the items from PVC came to just 14.14. trillion BTU.

The energy savings in that one category alone, amounting to 11.61 trillion BTU, equals two million barrels of petroleum, which would produce enough gasoline to operate 100,000 medium-size U.S. automobiles for one year.

IN TOYS

Taking one recent year as an example, just over 334 million pounds of four major plastics materials were used to make toys in the U.S. It would have taken nearly five times that amount of other materials—wood, glass, metal or rubber—to produce the equivalent number of toys.

Using non-plastics materials would consume 42 trillion BTU of energy. The toys made of plastics used only 15.08 trillion BTU of energy for their manufacture.

This energy savings of 26.92 trillion BTU is equivalent to 4.59 million barrels of petroleum. Put another way, that would provide gasoline enough to propel 24,000 modern automobiles approximately 100,000 miles.

INDUSTRIAL TANKS/DUCTS

Taking an example from one recent year, 150 million pounds of unsaturated polyester were used, with reinforcements (primarily glass fiber), to produce approximately 500 million pounds of corrosion-resistant industrial products, ranging from heavy duty duct work and hoods, to tanks and piping of various sizes and applications.

These reinforced polyester products replaced items made of a wide variety of metals, concrete and rubber, totalling some 2.5 billion pounds. The reinforced plastics materials came to just 150 million pounds.

The energy required to produce those products from non-plastics materials was calculated to be 67 trillion BTU while the reinforced polyester products consumed only 13.4 trillion BTU.

The resulting saving of over 53 trillion BTU is the equivalent of 9 million barrels of petroleum. That is sufficient energy to heat 100,000 homes in New England throughout a typical chilly winter there.

PLASTICS DERIVED FROM MAJOR FEEDSTOCKS*

(in millions of pounds)

Feedstock	Total Production		Plastics Derivatives		Plastics % of Total	
	1982	1981	1982	1981	1982	1981
Ethylene	24,700	29,400	17,415	17,820	71	61
Propylene	12,300	13,500	5,350	6,140	43	45
Benzene	7,850	9,600	5,575	6,525	71	68

*These data should not be construed to represent the entire feedstock needs of the U.S. plastics industry. They are based on 1981 and 1982 plastics production only and do not include feedstock needs for monomers, additives, and other chemicals not used in domestic production.

PLASTICS CONSUMPTION OF FEEDSTOCKS—1982

(millions of pounds)

ETHYLENE	Styrene Butadiene Latex	120	0.7%
	Styrene Acrylonitrile	20	0.1
	Acrylonitrile Butadiene Styrene	135	0.8
	Polyvinyl acetate	225	1.3
	Polyethylene	13,050	74.9
	Polystyrene	1,075	6.2
	Other Styrenes	40	0.2
	Polyvinyl chloride	2,750	15.8
		17,415	100.0%
PROPYLENE	Epoxy	115	2.2%
	Phenolic	950	17.8
	Polypropylene	3,825	71.5
	Polyester	190	3.6
	Styrene Acrylonitrile	35	0.5
	Acrylonitrile Butadiene Styrene	235	4.4
		5,350	100.0%
BENZENE	Acrylonitrile Butadiene Styrene	365	6.5%
	Styrene Acrylonitrile	60	1.1
	Styrene Butadiene Latex	290	5.2
	Polystyrene	2,910	52.2
	Other Styrene	100	1.8
	Epoxy	195	3.5
	Polyester	195	3.5
	Nylon	325	5.8
	Phenolic	1,135	20.4
		5,575	100.0%

SELECTED PLASTICS PRECURSORS

Precursor	Total Production		Plastics Derivatives		Plastics % of Total	
	1982	1981	1982	1981	1982	1981
Acrylonitrile	2,040	2,000	180	220	9	11
Bisphenol A	480	550	430	460	90	84
Butadiene	1,825	3,000	360	475	20	16
Cyclohexane	1,275	1,800	260	355	20	20
Formaldehyde	4,700	5,720	3,800	4,200	81	73
Maleic Anhydride	260	300	140	165	54	55
Phenol	2,140	2,575	1,650	1,915	77	74
Phthalic Anhydride	700	870	420	435	60	50
Styrene	5,925	6,680	4,410	5,115	74	77
Vinyl Acetate	1,875	1,935	1,875	1,935	100	100
Vinyl Chloride	6,500	6,870	6,500	6,870	100	100

Source: U.S. International Trade Commission, SRI International, Society of the Plastics Industry estimates

ADDITIVES FOR PLASTICS

ADDITIVE LUBRICANTS

These materials are added to plastics to assist flow in calendering, molding and extrusion by lubricating the metal surfaces in contact with the plastic. They also assist in knitting and wetting of the resin in mixing and milling operations. To be effective, lubricants must be compatible with the resins in which they are used, must not adversely affect the properties of end-products, and must be easily combined.

Examples: stearic acid, waxes, fatty acid esters, fatty acid amines.

ANTIOXIDANTS

They inhibit the oxidation of materials exposed to air or oxygen at normal or elevated temperatures. They are used in plastics which are subject to oxidative degradation, such as polyolefins, ABS, polystyrene, acetal and polyphenylene oxide.

Examples: alkylated phenols, amines, organic phosphites and phosphates, esters.

ANTISTATS

Chemicals which impart a slight to moderate degree of electrical conductivity to plastics compounds, thus preventing the accumulation of electrostatic charges on finished articles. They may be incorporated in the materials before molding, or applied to their surfaces after molding. They function either by being inherently conductive or by absorbing moisture from the air.

Examples: quaternary ammonium compounds, anionics, amines.

BLOWING AGENTS [FOAMING AGENTS]

Substances which alone or in combination with other substances are capable of producing a cellular structure in a plastic or rubber mass. Thus, the term includes compressed gases which expand when pressure is released, soluble solids that leave pores when leached out, liquids that develop cells when they change to gases, and chemical agents that decompose or react under the influence of heat to form a gas.

Examples: azodicarbonamide, modified azos, OBSH, HTBA.

COLORANTS

Dyes or pigments which impart color to plastics. The dyes are synthetic or natural compounds of submicroscopic or molecular size, soluble in most common solvents, yielding perfectly transparent colors. The pigments are organic and inorganic substances with larger particle sizes and usually insoluble in the common solvents. Colorants are added to plastics by dry coloring (tumbling the colorant with the base or compounded resin); by extrusion coloring (extruding a dry colored mixture and chopping it into pellets to be reprocessed); by masterbatching; or by stirring colorants or dispersions thereof into liquid plastisols or resin systems.

Examples: titanium dioxide, iron oxides, anthraquinones, carbon black.

FLAME RETARDANTS

Materials that reduce the tendency of plastic articles to burn. They are usually incorporated as additives during compounding, but sometimes are applied to surfaces of finished articles.

Examples: antimony trioxide, chlorinated paraffins, bromophenols.

HEAT STABILIZERS

Agents used in compounding some plastics to assist in maintaining the physical and chemical properties of the compounded materials at suitable values throughout the processing and service life of the material and/or the parts made therefrom. They protect plastics from the effects of heat such as changes in color, decrease in mechanical and electrical properties, and undesirable surface conditions.

Examples: lead, barium-cadmium, tin, calcium-zinc.

ORGANIC PEROXIDES

Thermally decomposable compounds which can initiate polymerization reactions and effect cross-linking upon decomposition. The rate of decomposition can be controlled by means of promoters or accelerators added to the system to increase the decomposition rate; or by inhibitors when it is desired to retard the decomposition.

Examples: MEK peroxide, benzoyl peroxide, alkyl peroxide, peresters.

PLASTICIZERS

Materials incorporated in a plastic or elastomer to increase its flexibility, workability or distensibility. Most plasticizers are nonvolatile organic liquids or low-melting point solids, which function by reducing the normal intermolecular forces in a resin thus permitting the macromolecules to slide over one another more freely.

Examples: adipates, azelates, trimellitates, DOP/DIOP/DIDP.

ULTRAVIOLET STABILIZERS (UV LIGHT ABSORBERS)

Chemical agents which absorb or screen out radiation beyond the violet end of the spectrum of visible radiations. Such radiation has sufficient energy to initiate reactions leading to the degradation of many plastics. These agents are often combined with other additives, e.g. heat stabilizers and antioxidants, with which they act in synergistic fashion.

Examples: benzophenones, benzotriazole, salicylates.

Source: Whittington's Dictionary of Plastics

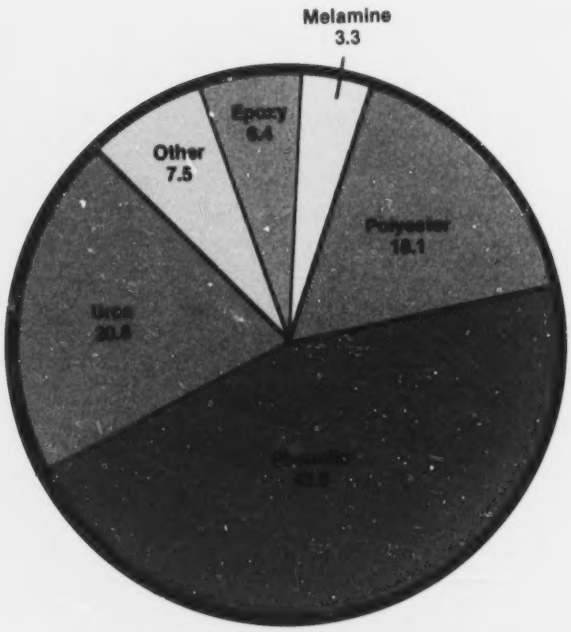
CONSUMPTION OF ADDITIVES
(millions of pounds)

Type	1978	1979	1980	1981	1982
Additive Lubricants	78	104	77	88r	83
Antioxidants	35	36	32	34	31
Antistats	5	5	5	6	6
Blowing Agents	15	16	10	11	11
Colorants	320	342	307	331	322
Flame Retardants	453	451	475	420r	376
Heat Stabilizers	88	92	83	86	78
Organic Peroxides	32	39	34	37	33
Plasticizers	1,615	1,654	1,485	1,505	1,373
Ultraviolet Stabilizers	4	5	5	5	5

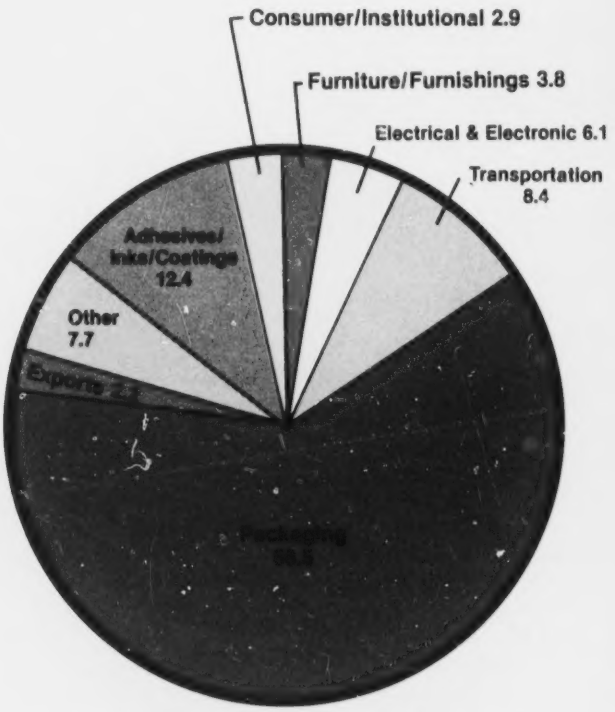
Source: Modern Plastics Magazine
r = revised from 1982 edition

THERMOSETTING RESINS

Plastics which in their final state as finished articles are substantially infusible and insoluble. They are often liquids at some state of their manufacture or processing, which are cured by heat, catalysts or other chemical means. After being fully cured, thermosets cannot be resoftened by heat.



1982 PERCENT OF THERMOSET RESIN
SALES & CAPTIVE USE
BY MATERIAL



1982 PERCENT OF THERMOSET RESIN
SALES & CAPTIVE USE
BY MAJOR MARKET

EPOXY

Manufacturers*

Celanese Specialties Co.
Ciba-Geigy Corp.
Dow Chemical U.S.A.
Morton Industries
Reichhold Chemicals Inc.
Shell Chemical Co.
Union Carbide Corp.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1982.

Production and Sales & Captive Use
(millions of pounds)

Year	Production	Sales & Captive Use
1978	299	316
1979	361	332
1980	315	319
1981	336	332
1982	286	301
Compound Growth Rate 1977-1982	1.9%	1.6%

Percent of Total U.S. Sales & Captive Use	
1978	0.90
1979	0.86
1980	0.91
1981	0.90
1982	0.86

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

EPOXY
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Bonding & adhesives	18	17	18	18	15
Flooring, paving and aggregates	17	20	19	20	18
Protective coatings	142	146	137	137	122
Fiber reinforced laminates & composites	54	60	63	66	58
Tooling, casting, and molding resins	31	31	26	29	24
All other uses	23	22	20	21	25
Total	285	296	283	291	262

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	*	*	*	*	*
Packaging	*	*	*	*	*
Building/Construction	34	28	48	49	44
Electrical/Electronic	50	66	55	58	60
Furniture/Furnishings	—	—	—	—	—
Consumer & Institutional	—	*	—	*	—
Industrial/Machinery	*	*	—	*	*
Adhesives, Inks & Coatings	153	159	150	151	134
All Other	46	43	30	33	24
Exports	31	36	36	41	39
Total	316	332	319	332	301

*Included in All Other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

PHENOLIC

Manufacturers*

Acme Resins Co.
Ametek, Haveg Div.
Ashland Chemical Co.
Bendix Corp.
Borden Chemical Co., Inc.
Chembond Corp.
Formica Corp.
General Electric Co.
Georgia-Pacific Corp.
Gulf Oil Chemicals Co.
Inland Steel Container Co.
Inmont Corp.
Ironsides Resins, Inc.
Kesco Co.
Koppers Co.
Masonite Corp.
Monsanto Co.
Occidental Chemical Co.
Owens-Corning Fiberglas Corp.
Pioneer Plastics Corp.
Plaslok Corp.
Plastics Engineering Co.
Polymer Applications Inc.
Polyrez Co., Inc.
Raybestos-Manhattan Corp.
Reichhold Chemicals, Inc.
Rogers Corp.
Union Carbide Corp.
Uniroyal Chemical Div. Uniroyal, Inc.
Valite Div. Valentine Sugars, Inc.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1982.

Production and Sales & Captive Use**
(millions of pounds)

Year	Production	Sales & Captive Use
1978	1,827	1,788
1979	1,781	1,732
1980	1,499	1,517
1981	2,333	2,375
1982	2,006	2,060
Compound Growth Rate		
1977-1982	n.c.	n.c.

	Percent of Total U.S. Sales & Captive Use
1978	5.10
1979	4.47
1980	4.31
1981	6.43
1982	5.87

*Gross weight basis of reporting begun in 1981.
n.c. = not comparable.
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

PHENOLIC
DOMESTIC CONSUMPTION BY END-USE**
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Molding Compounds	334	310	246	249	192
Bonding & adhesive resins for:					
Laminating	114	109	97	134	127
Coated & bonded abrasives	40	40	34	37	25
Friction materials	40	39	35	29	25
Insulation materials	279	287	271	362	347
Foundry & shell molding	111	113	80	82	56
Plywood	535	511	445	1,110	1,012
Fibrous & granulated wood	123	119	88	201	146
Resins sold to Rubber Industry	25	23	28	24	23
All other	59	57	74	59	51
Protective coatings	23	21	24	26	18
All other uses	79	73	72	42	23
Total	1,762	1,702	1,494	2,355	2,045

**Gross weight basis of reporting begun in 1981.
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET**
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	199	171	135	167	129
Packaging	11	11	10	*	*
Building/Construction	813	940	858	1,672	1,543
Electrical/Electronic	184	213	181	209	170
Furniture/Furnishings	18	7	11	25	26
Consumer & Institutional	48	40	33	*	*
Industrial/Machinery	24	21	21	27	*
Adhesives, Inks & Coatings	141	222	186	166	73
All Other	80	77	59	89	104
Exports	25	30	23	20	15
Total	1,543	1,732	1,517	2,375	2,060

**Gross weight basis of reporting begun in 1981
*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

UNSATURATED POLYESTER

Manufacturers*

Advance Coatings Corp.
Alpha Chemical Corp.
Ashland Chemical Co.
Cook Paint & Varnish Co.
Dow Chemical U.S.A.
Freeman Chemical Corp.
Glidden Coatings & Resin Div. SCM Corp.
ICI Americas, Inc.
Inmont Corp.
Interplastics Corp.
Koppers Co.
Owens-Corning Fiberglas Corp.
Pioneer Plastics Corp.
PPG Industries, Inc.
Reichhold Chemicals, Inc.
Shell Chemical Co.
Sherwin Williams Co., The
Sohio Chemical Co.
USS Chemicals Co.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1982.

Production and Sales & Captive Use
(millions of pounds)

Year	Production	Sales & Captive Use
1978	1,209	1,199
1979	1,147	1,152
1980	947	949
1981	997	977
1982	865	851
Compound Growth Rate 1977-1982	−4.0%	−4.0%

	Percent of Total U.S. Sales & Captive Use
1978	3.42
1979	2.98
1980	2.70
1981	2.64
1982	2.42

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

UNSATURATED POLYESTER
MAJOR DOMESTIC MARKETS
(in millions of pounds)

	1978	1979	1980	1981[r]	1982
Domestic Reinforced Plastics, Total	952	906	739	764	629
Marine and marine accessories	249	227	171	169	156
Transportation	119	105	80	84	65
Auto, trucks, buses, etc.	95	86	63	65	53
Other transportation	24	19	17	19	12
Construction	338	325	287	301	279
General construction	135	122	114	122	114
Bathroom components & fixtures, general purpose tanks & pipes	118	106	79	78	75
Corrosion resistant tanks, pipes, etc.	85	97	94	101	90
Electrical generation, transmission and distribution	30	26	23	22	17
Consumer goods	83	85	66	66	51
Major appliances and parts	15	11	7	10	19
Recreational goods, toys, etc.	19	23	19	24	22
Other consumer goods	49	51	40	32	10
Gel coats	46	37	26	32	31
Other reinforced	87	101	86	90	30
Domestic Non-Reinforced Plastics, Total	232	231	214	202	214
Castings	159	160	144	123	103
Furniture	10	7	6	7	4
Cultured marble & onyx	60	67	63	61	62
Other	89	86	75	55	37
Autobody putty	50	45	41	45	60
Surface and protective coatings	6	5	5	5	4
Bonding and adhesives	4	5	5	3	2
Other non-reinforced	13	16	19	26	45

r = revised from 1982 edition

Source: Quarterly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	383	362	261	259	244
Packaging	—	—	*	*	—
Building/Construction	423	434	384	401	353
Electrical/Electronic	37	39	25	33	26
Furniture/Furnishings	24	26	26	24	3
Consumer & Institutional	138	138	100	94	95
Industrial/Machinery	80	88	*	*	—
Adhesives, Inks & Coatings	22	15	10	9	7
All Other	77	36	132	146	115
Exports	15	14	11	11	8
Total	1,199	1,152	949	977	851

*Included in all other.

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

UREA

Manufacturers*

American Cyanamid Co.
Borden Chemical Co., The
Celanese Specialties Co.
Chembond Corp.
Cook Paint & Varnish Co.
Dan River Inc.
Georgia-Pacific Corp.
Grifftex Chemicals, Inc.
Guardsman Chemicals, Inc.
Gulf Oil Chemicals Co.
Kesco Co.
Maplechem Inc.
Monsanto Co.
Perstorp U.S., Inc.
Pioneer Plastics Corp.
Plastics Manufacturing Co.
Reichhold Chemicals, Inc.
Valchem Div. United Merchants

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1982.

Production and Sales & Captive Use
(millions of pounds)

Year	Production	Sales & Captive Use
1978	1,122	1,103
1979	1,367	1,355
1980	1,165	1,147
1981	1,165	1,139
1982	998	976
Compound Growth Rate 1977-1982	0.7%	0.5%

Percent of Total U.S. Sales & Captive Use	
1978	3.15
1979	3.50
1980	3.26
1981	3.08
1982	2.78

Source: Monthly Statistical Report, SPI Committee on Resin Statistics. as compiled by Ernst & Whinney.

MELAMINE

Manufacturers*

American Cyanamid Co.
American Hoechst Corp.
Borden Chemical Co., The
Celanese Specialties Co.
Chembond Corp.
Cook Paint & Varnish Co.
Dan River Inc.
Formica Corp.
Georgia-Pacific Corp.
Grifftex Chemicals, Inc.
Guardsman Chemicals, Inc.
Maplechem Inc.
Monsanto Co.
Owens-Corning Fiberglas Corp.
Perstorp U.S., Inc.
Pioneer Plastics Corp.
Plastics Manufacturing Co.
Reichhold Chemicals, Inc.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1982.

Production and Sales & Captive Use
(millions of pounds)

Year	Production	Sales & Captive Use
1978	202	196
1979	200	192
1980	167	166
1981	179	175
1982	158	155
Compound Growth Rate 1977-1982	−4.6%	−5.3%

Percent of Total U.S. Sales & Captive Use	
1978	0.56
1979	0.50
1980	0.47
1981	0.47
1982	0.44

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

UREA AND MELAMINE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Paper treating & coating resins	71	76	70	73	68
Bonding & adhesive resins for:					
Laminating	30	29	27	32	27
Plywood	90	86	74	74	64
Fibrous & granulated wood	813	1,029	896	884	759
Protective coatings	93	88	66	69	64
All other uses	178	215	162	158	132
Total	1,275	1,523	1,295	1,290	1,114

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION OF UREA/MELAMINE BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	25	24	*	*	*
Packaging	25	34	*	*	44
Building/Construction	662	915	833	820	712
Electrical/Electronic	49	52	*	*	*
Furniture/Furnishings	274	206	168	181	148
Consumer & Institutional	45	35	51	48	*
Industrial/Machinery	—	—	*	*	—
Adhesives, Inks & Coatings	125	134	99	90	65
All Other	70	123	144	151	145
Exports	24	24	18	24	17
Total	1,299	1,547	1,313	1,314	1,131

*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

MISCELLANEOUS THERMOSETS
(in millions of pounds)

	Production				
Resin	**1977**	**1978**	**1979**	**1980**	**1981**
Alkyds	753	754	755	703	717
Furfuryl-type	n.a.	17	31	25	24
Silicones	18	16	20	12	17
Dicyandiamide	2	2	2	2	2
Other[1]	91	60	70	169	107

	Sales				
Resin	**1977**	**1978**	**1979**	**1980**	**1981**
Alkyds	434	415	408	392	420
Furfuryl-type	n.a.	16	30	25	23
Silicones	11	11	11	8	8
Dicyandiamide	2	2	2	2	2
Other[1]	70	49	61	121	78

n.a. = not available
[1]Includes acetone-formaldehyde, glyoxal-formaldehyde, polybutadiene, and other thermosets.
Source: *Synthetic Organic Chemicals*, U.S. International Trade Commission.

POLYURETHANE FOAMS

TECHNICAL BACKGROUND

Urethane foams are cellular plastics generally formulated by the reactions of two liquids—a polyol and a polyisocyanate—in the presence of a blowing agent, a catalyst, a surfactant, and perhaps other special additive chemicals such as fire retarding agents. By altering the choice of polyol, the type of isocyanate and other ingredients, substantially different polyurethane foams can be made. Depending on their physical characteristics, these foams are classified as flexible, semi-flexible, or rigid with densities ranging from one to more than 60 pounds per cubic foot. The distinction between rigid and flexible urethane foams is fundamental in that their use and disposal characteristics are very different, as are the problems associated with each. Polyisocyanurate foams are considered to fall into the class of rigid urethane foams, since their physical and mechanical properties are similar but they do have improved thermal and combustibility properties.

Production of *rigid* urethane foam involves metering the resin mix (polyol, surfactant, blowing agent and catalyst) and isocyanate through a high speed mixer. The blended components may be used for bun stock, molding, frothing, spraying or continuous laminating.

Most *flexible* urethane foam is produced in a continuous bun up to 8 feet wide, 45 inches high and cut into any desired length. After curing, the buns are sold to fabricators or cut into various shapes and sizes depending on end use (usually cushioning for furniture, mattresses and bed pillows). Flexible urethane foams can be molded to produce complex shapes without extensive fabrication. Final decision concerning the type and quality of ingredients, including special fire retardants and foam properties to be formulated, are made by the individual foamers, molders and applicators in response to demands of their consumer markets.

Because of the extraordinary variety of formulations possible, urethane foams, both rigid and flexible, can be produced to meet a broad spectrum of properties covering density, load bearing, resiliency, compressive strength, closed cell content, water vapor permeability, water absorption, shear and impact strength, elasticity, heat resistance, thermal conductivity and various combustibility properties. Proper care must be exercised to insure that the formulation is not only functionally and economically efficient, but also safe for the intended use.

USE

Urethanes are essentially a new technology material which, while being similar chemically to many other plastics, have unique use characteristics. They are currently the most efficient insulating material on the market and the most widely used cushioning materials; they perform exceptionally well in buoyancy, as a reinforcement material, as an impact absorber, as a sound absorber, as a protective coating, as an adhesive, as a sealant and as a decorative material. Due to their wealth of functional properties and their high degree of cost competitiveness relative to substitutes, urethanes have experienced broad consumer acceptance and market growth.

USE OF FLEXIBLE FOAM

Flexible foam normally ranges in density from 1 to 3 pounds per cubic foot. It has high resiliency and its shape can be easily altered. It can be cut, molded, laminated or bonded to meet a broad spectrum of product and application requirements.

POLYURETHANE FOAM—DOMESTIC SALES & CAPTIVE USE
(in millions of pounds)

	1978	1979	1980	1981	1982	Compound Growth Rate 1977-1982
Flexible and Semi-Flexible Foam						
Bedding (excluding sofa beds)	161	152	139	143	125	−3.4%
Furniture	484	461	432	437	431	−0.6
Packaging	33	31	23	35	34	+4.0
Rug and Underlay	132	143	161	165	141	−0.7
Textile Laminates	34	42	38	36	34	+4.0
Transportation	390	352	242	227	216	−10.8
Miscellaneous	71	44	58	40	43	−7.0
Scrap	136	150	80	101	103	−7.5
Total Flexible and Semi-Flexible Foam	1,441	1,375	1,173	1,184	1,127	−4.1%
Rigid Foam						
Appliances	79	84	69	76	80	−0.2%
Building Construction	283	322	315	328	328	+6.8
Furniture	33	25	22	16	21	−8.1
Marine Flotation	18	17	15	15	12	−5.6
Packaging	24	31	34	42	43	+15.4
Transportation	58	49	46	41	32	−11.2
Miscellaneous	25	27	38	42	31	+8.1
Total Rigid Foam	520	555	539	560	547	+3.3%
Grand Total Foam	1,961	1,930	1,712	1,744	1,674	−2.0%

Source: Polyurethane Foam End-use Survey,
SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

In Furniture—For furniture use, flexible foam is generally produced in slab form and then cut into cushioning for sofas and chairs. The cushioning market is now dominated by flexible urethane foam. In addition to ease of production, its benefits include relatively uncomplicated fabrication, good load bearing characteristics, and comparatively low cost. High resilience foam molding is a growing segment for furniture consumption due to its ability to produce custom contoured pieces in volume. Cold-curing reduces the need for special oven cures and time-consuming cooling cycles. The finished product also has better seating characteristics than hot molded foam.

Integral skin (self-skinning) flexible foam has properties which compare favorably with its conventional alternative (molded foam covered with vinyl sheet). Due to its excellent flow characteristics, it can be poured into very complex closed molds for a variety of shapes. It can be produced in soft grades for seating or in firm grades for automotive soft-trim parts.

In Transportation—The second largest market for flexible urethane foam is in the transportation industry. In 1970, approximately 19 pounds of foam were used in the average passenger car. By 1979 this had increased to approximately 45 pounds per car. Most of this flexible foam is used in connection with providing comfort and safety. Since September 1, 1972, foams used in this application have been subject to Federal Motor Vehical Safety Standard No. 302—Flammability of Interior Materials—Passenger Cars, Multipurpose Passenger Vehicles, Trucks, and Buses.

In the safety area, semi-flexible foam with its low resiliency and high energy absorption properties is used for dash boards, head rests and arm rests. High density or micro cellular foam is also used in car bumpers for its impact resistance. Reticulated polyester urethane foam is being used as a safety measure in gasoline tanks of racing cars. Some manufacturers are experimenting with foam in door panels and roofs to improve impact resistance, to lessen noise and vibration, to insulate in winter and summer, and generally to increase passenger safety. Urethane consumption will be stimulated further by new Federal safety regulations requiring more impact-absorbing material in all new cars.

In Bedding—Relative to its two competitors, latex rubber and inner springs, urethane foam bedding exhibits comparable comfort and lower cost. It weighs 30 per cent less than inner spring mattresses and as much as 50 per cent lower than foamed rubber. It is easy to turn, can be made to a controlled degree of firmness, has excellent chemical resistance, is long-lasting, non-allergenic and sterilizable. The combustibility of the mattress composite is regulated by the Consumer Product Safety Commission Standard FF 4-72—Flammability of Mattresses.

In Apparel/Textiles—Flexible urethane foam can be bonded or laminated to almost any fabric. In the apparel industry, urethane foam is used to bond face fabrics to linings. This provides cost savings by eliminating the need to cut and sew in separate linings. Foam-bonded and foam-laminated fabrics have been accepted by the large home sewing market because they are very easy to work with, can provide warmth without weight, are comfortable and wrinkle resistant, and they retain their shape. This technique is also applied to shoes, drapes, slip covers, sleeping bags, etc.

In Carpets—Urethane foam is used both as separate carpet pads and on foam-backed carpets. Growth opportunities in this market are good: urethane foam is lighter than its competitors while being less expensive and odor free; it has good tensile strength, is both non-allergenic and resistant to deterioration from moisture, insects, etc., and has superior aging characteristics. Foam-backed carpet composites fall under the jurisdiction of Consumer Product Safety Standards FF 1-70 and FF 2-70 for the surface combustibility of carpets and rugs. Other agencies also have regulations of combustibility covering separate carpet pads.

USE OF RIGID URETHANE FOAM

Rigid foam, like flexible, has a wide range of formulations, densities and uses. For most applications, its density ranges from 1 to 3 pounds per cubic foot, but furniture applications may utilize foams with densities up to 45 pcf.

Rigid foam has good dimensional stability both at high and low temperatures, extremely good insulating values, high compressive strength, relatively low water absorption, excellent buoyancy, and can be molded into rather intricate shapes. It is easy to produce, extremely versatile, and relatively inexpensive. It can be produced by spray, pour-in-place, molding, continuous slab or laminating techniques.

In Construction—Rigid foam insulation is durable and competitive in cost, and has extremely low thermal conductivity and water absorption qualities. Relative to its competitors, it saves from 10% to 30% in comparable thicknesses on the cost of heating and cooling those structures which it insulates as well as proportionately decreasing heating and cooling equipment size. This fact becomes increasingly meaningful with the growing use of more expensive electric heat and the growing critical need to conserve the nation's dwindling energy resources.

Since the development of foam systems acceptable to building code officials, their use has been more generally accepted. Foam has been used successfully as sprayed-on insulation for homes and commercial buildings, with proper protection for fire safety, and as insulation for storage tanks. The Urethane Safety Group of SPI recommends covering rigid urethane foam insulation with a suitable flame barrier as soon as possible after installation.

In Refrigeration—Expanding use of frozen foods has contributed to the increased use of rigid foam in the refrigeration industry. Rigid urethane, used primarily in refrigerators and freezers, has the largest share of the appliance insulation market due to its low thermal conductivity, flexibility in application (foamed-in-place, spray or slab) and the strength it provides to the structure when the foam is bonded to the inside and outside panels. Also, relative to its competitors, rigid foam's superior insulating qualities permit thinner wall construction thus allowing in-house appliances substantially more interior refrigerator or freezer space for the same outside dimensions.

Rigid foam is also considered to be the best available insulating material for use in equipment for transporting frozen food. Specifically, in refrigerated rail or highway vehicles, half as much rigid foam is needed to produce the same insulation efficiency as is produced by glass fibers.

In Furniture/Interior Decoration—The potential for rigid foam appears to be unlimited because it can be used both structurally and decoratively in the higher densities (4 to 40 pounds per cubic foot). It is comparable to or better than other traditional materials considering that: it has uniform reproducible quality, can be mass produced in a variety of densities and textures, and has outstanding impact resistance. It appears in many forms—tables, cabinets, chair shells, picture frames, decorative beams, wall panels, etc. Certain types of rigid foam furniture have been formulated to provide some degree of flame retardant characteristics which make them more readily acceptable among public or private institutions such as schools and hospitals. Programs are underway studying the combustibility characteristics of these types of foams.

In Transportation—Rigid foam is already used as insulation for car air conditioners, in insulating railroad cars and in trailer trucks. With its superior strength to weight properties, rigid foam can eventually be used for a broad array of automobile structural and mechanical parts, including exteriors. Experimental cars have been built which are virtually all urethane. Rigid foam will also be a key safety material due to its very efficient energy absorption characteristics.

In Marine Use—In addition to its insulation benefits, rigid foam has superior buoyancy characteristics. It has been used successfully in marine salvage operations, in life saving gear, in nuclear submarines, rafts, swimming pools, sporting goods and numerous other floating articles.

POLYURETHANE PRODUCTS

In addition to foams, urethane chemicals find their way into a broad range of other polyurethane products. While the foams represent the dominant end-use outlets for chemicals, these other polyurethane products constitute a sizeable marketplace in themselves, and hence are worthy of separate mention.

The three major subcategories within the Polyurethane Product Reporting Program (of SPI) are Castable Types, Millable Gums, and Thermoplastic Types. The Millable Gums quantities are very small, and the Thermoplastic Types are also overshadowed by the Castables.

Within the Castables subcategory, there is a further break-down among Solid Materials, Microcellular Materials, and a catchall covering Adhesives, Sealants and Coatings. These three product/market areas are roughly comparable in size at present.

The various categories of Polyurethane Products have widely differing properties, end-uses, and growth rates. The Castable/Solid materials represent a well-established product line with a wide spectrum of end-uses which encompass both industrial, mechanical and consumer goods. Growth has been modest. In contrast, the Microcellular types represent new products, still in their rapid growth phase. Primary uses to date have been in automotive applications and for shoe soles. The Adhesives, Sealants, and Coatings grouping by and large represents established applications with modest growth. Similarly, Millable Gums are sold into established markets. The final category—Thermoplastic types—present a more complicated picture. The materials have been around for more than ten years and growth of late has been disappointing. Major markets include automotive, industrial uses such as cable jacketing, and molded parts for both industrial and consumer goods. Depending upon application development work and the dymanics of competing products, Thermoplastic Urethanes have the potential for capturing significantly increased volume of business in the years ahead.

PRODUCTION OF POLYURETHANE PRODUCTS
(thousands of pounds)

	1978	1979	1980	1981	1982*
Castable Types, Total	237,959	269,501	207,095	249,189	224,000
Solid	72,920	83,975	71,771	82,593	—
Microcellular	63,394	71,204	63,120	59,308	—
Adhesives, Sealants & Coatings	101,645	114,322	72,204	107,288	—
Millable Gum Type	1,069	1,505	2,584	2,239	1,600
Thermoplastic Type	39,273	49,761	45,793	45,678	31,000
Total Polyurethane Products	278,301	320,767	255,472	297,106	256,600

*Industry estimate.

Source: Semi-annual Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

ISOCYANATES
(in millions of pounds)

Year	Production			Sales & Captive Use
	Total	TDI*	Other Isocyanates	Total
1978	1,129	611	518	1,138
1979	1,248	681	567	1,234
1980	1,126	536	590	1,079
1981	1,147	537	610	1,138
1982	1,042	547	495	1,052

*Toluene Diisocyanate (80/20 mixture)

POLYETHER POLYOLS
(in millions of pounds)

Year	Production	Sales & Captive Use
1978	1,404	1,399
1979	1,510	1,491
1980	1,225	1,231
1981	1,264	1,266
1982	1,111	1,209

POLYESTER POLYOLS
(in millions of pounds)

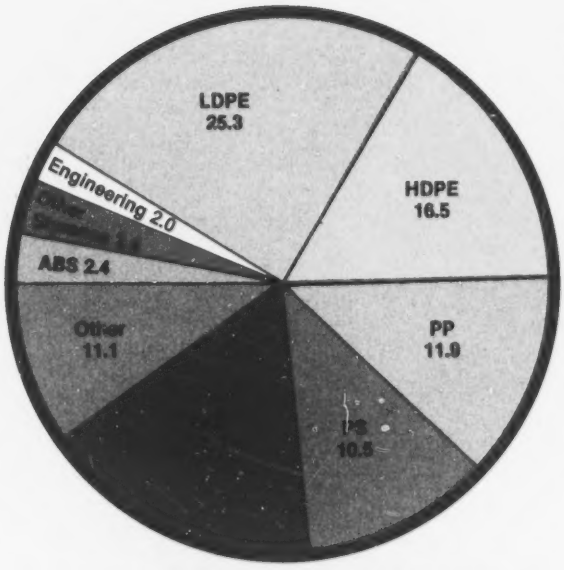
Year	Production	Sales & Captive Use
1978	42	41
1979	43	41
1980	42	40
1981	47	46
1982	28	28

Participating Companies—1982	Isocyanates	Polyether Polyols	Polyester Polyols
BASF Wyandotte Corp.	X	X	
Chemetic Systems		X	
Choate Chemical		X	
Dow Chemical U.S.A.	X	X	
E.I. duPont de Nemours & Co.		X	
ICI Americas	X		
Mobay Chemical Corp.	X	X	X
Olin Corp.	X	X	
Owens-Corning Fiberglas Corp.		X	
PPG Industries		X	
Quaker Oats Co.		X	
Reichhold Chemicals, Inc.		X	
Ruco Div. Occidental Chemicals Corp.			X
Stepan Chemical Co.		X	
Texaco, Inc.		X	
U.C.T., Inc.		X	
Union Carbide Corp.		X	
Uniroyal Chemical Co.		X	X
The Upjohn Co.	X	X	
Witco Chemical Co.		X	X

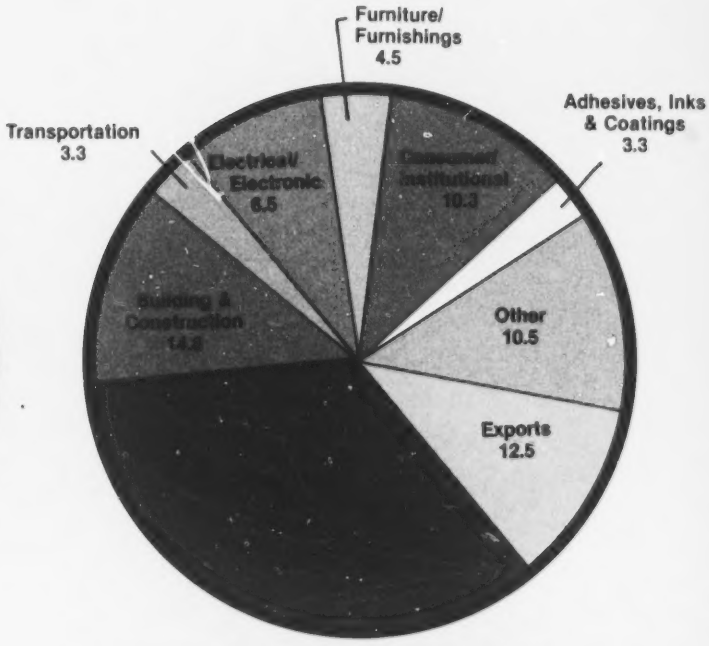
Source: Quarterly Polyols and Isocyanates Reports, SPI Committee on Resin Statistics as compiled by Ernst & Whinney.

THERMOPLASTIC RESINS

Plastics which in their final state as finished articles are capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature and physical change.



1982 PERCENT OF THERMOPLASTIC SALES & CAPTIVE USE BY MATERIAL



1982 PERCENT OF THERMOPLASTIC SALES & CAPTIVE USE BY MAJOR MARKET

ABS AND SAN

Manufacturers*

Borg Warner Chemicals
Dow Chemical U.S.A.
B.F. Goodrich Chemical Co.
Carl Gordon Industries
Mobay Chemical Co.
Monsanto Company
USS Chemicals

*Those companies who participated in the SPI Monthly Statistical Report in 1982.

Production and Sales & Captive Use
(millions of pounds)

Year	Production		Sales & Captive Use	
	ABS	SAN	ABS	SAN
1978	1,134	120	1,118	121
1979	1,191	124	1,183	126
1980	920	111	916	103
1981	916	107	900	105
1982	740	91	737	85
Compound Growth Rate 1977-1982	−7.1%	−4.6%	−7.0%	−5.5%

Percent of Total U.S. Sales & Captive Use

	ABS	SAN
1978	3.19	0.35
1979	3.06	0.33
1980	2.60	0.29
1981	2.44	0.28
1982	2.10	0.24

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

ABS AND SAN
MAJOR DOMESTIC MARKETS
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
ABS					
Consumer & Institutional	n.a.	n.a.	n.a.	132	104
Pipe, Conduit & Fittings	356	302	208	180	111
Electrical & Electronic	n.a.	229	193	195	181
Transportation	n.a.	n.a.	154	161	145
Other	725	593	304	180	148
Total	1,081	1,124	859	848	689
SAN					
Total	104	108	90	91	75
Grand Total	1,185	1,232	949	939	764

n.a. = not available.
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION OF ABS & SAN BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	303	317	185	177	156
Packaging	21	33	26	29	*
Building/Construction	346	341	234	194	124
Electrical/Electronic	278	257	265	209	203
Furniture/Furnishings	8	16	8	*	*
Consumer & Institutional	130	139	93	165	129
Industrial/Machinery	21	15	13	*	*
Adhesives, Inks & Coatings	—	—	—	—	—
All Other	78	114	125	165	153
Exports	54	77	69	66	57
Total	1,239	1,309	1,019	1,005	822

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

ENGINEERING THERMOPLASTIC RESINS

The following resins are generally considered to be included in the category of engineering resins: fluoropolymers; polyimides and polyamide-imides; modified polyphenylene oxide; polyphenylene sulfide; thermoplastic polyester resin; polycarbonate; polysulfone; and acetal. Other materials which may be used in similar applications such as ABS, SAN, and nylon are mentioned elsewhere in Facts & Figures. Fluoropolymers, likewise, are mentioned elsewhere but their production and sales & use data are included below.

Engineering resins are characterized by a combination of high ratings for mechanical, thermal, electrical, and chemical properties. Fillers such as glass, carbon, metallic oxides, metallic powders, calcium carbonate, and silica products, and reinforcements such as fibrous glass, asbestos, carbon, and other inorganic and organic fibers are added to improve these properties.

Typical Applications

Acetal (AC)	Sinks, faucets, electrical switches, gears, aerosol bottles, meat hooks, lawn sprinklers, ballcocks, shaver cartridges, zippers, telephone push-buttons.
Polycarbonate (PCO)	Helmets, power tool housings, battery cases, safety glass, auto lenses, 5 gal. bottles
Polyphenylene Sulfide (PPS)	Electrical connectors, coil forms, lamp housings.
Thermoplastic Polyester (TP)	Electrical bobbins, TV tuners, fuse cases, bearings, cams, auto ignition coil caps, speedometer frames, pump impellers and housings.
Polysulfone (PSO)	Electrical connectors, meter housings, coffeemakers, camera bodies, auto switch and relay bases, light-fixture sockets, fuel cell components, battery cases.
Modified Polyphenylene Oxide (PPO)	Auto dashboards, pumps, shower heads, plated auto grilles and trim, appliance housings, wiring splice devices, protective shields.
Polyimide (PI)	Radomes, printed circuit boards, turbine blades.
Polyamide-imide (PAI)	Valves, gears, pumps, high temperature magnet wire enamels.

ENGINEERING THERMOPLASTIC RESINS

Manufacturing

Known Manufacturers	AC	PCO	PPS	TP	PSO	PPO	PI	PAI	FLUORO-POLYMERS
Allied				X					X
American Hoechst				X					
Amoco Chemical							X	X	
Celanese Engineering Resins	X			X					
Dupont	X			X			X		X
Eastman Chemical				X					
GAF				X					
General Electric		X		X		X			
Goodyear				X					
ICI Americas									X
Mobay Chemical		X							
Phillips Petroleum			X						
Rohm and Haas				X					
Union Carbide					X				

(see opposite page for complete names of resins.)

Production and Sales & Captive Use
(in millions of pounds and dollars)

Year	Production	Sales & Captive Use	Sales (excl. Captive & Exports)
1978	648	639	$579
1979	729	709	699
1980	673	645	715
1981	676	633	806
1982	569	596	755

Compound Growth Rate of Sales & Captive Use	
1977-1982	0.7%
1981-1982	– 5.8%

Source: SPI Committee on Resin Statistics as compiled by Ernst & Whinney

Distribution by Major Market
(In millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	88	101	78	76	80
Packaging	3	8	1	1	1
Building & Construction	78	97	86	96	82
Electrical/Electronic	176	231	216	211	192
Consumer/Institutional	38	38	32	37	45
Industrial/Machinery	77	67	55	58	52
Other	50	21	42	34	18
Exports	129	146	106	120	126
Total	639	709	645	633	596

Source: Industry estimates.

FLUOROPOLYMERS

The fluoropolymers industry received its start with the discovery of polytetrafluoroethylene in 1938. Later during World War II its first use was as a gasket in packing materials in extremely corrosion-resistant applications for the Manhattan project. As the war progressed and radar became airborne, polytetrafluoroethylene was found to be the only insulation that had the required combination of electrical properties, toughness, and heat resistance to perform properly. Since this beginning other fluoropolymer resins have been made available and are in general use today. They are chlorotrifluoroethylene (CTFE), polyvinyl fluoride (PVF), polyvinylidene fluoride (PVF_2), fluorinated ethylene propylene (FEP), ethylene tetrafluoroethylene (ETFE), ethylene chlorotrifluoroethylene (ECTFE), and perfluoroalkoxy copolymerized with tetrafluoroethylene (PFA).

These fluoropolymer resins have an outstanding combination of properties and are capable of performance unavailable from any other group of resins. They have outstanding chemical resistance and are inert to virtually all chemicals and solvents, the most corrosive fuels or oxidizers and in the most difficult atmospheres. In addition, they do not contaminate other products with which they come in contact. They have high stable electric properties with minimum dissipation factor, low dielectric constants, high volume and surface resisitivity, high dielectric strength, and are constant over a wide range of frequencies and temperatures. The useful temperature range for these resins is from $-400°$ to $+550°$F. They are among the most slippery solids known and provide excellent sliding surfaces for bearings and other applications. They have good physical properties which can be improved by reinforcing agents and are tough and flexible even at very low temperatures. Finally, they are unaffected by exposure to sun, freezing cold, or outdoor weathering of any kind.

As a result of this unusual combination of properties, fluoropolymers are used in virtually all areas of industry today. The most important of these are: (1) Electric—in shrinkable tubing, coaxial cable connectors, slip-on insulation, connectors, capacitors, and insulated wire; (2) Chemical—in pipe fittings, expansion joints, valves, seals, gaskets, seatings, laboratoryware, linings for valves and pumps, thread sealants, and other sealant products; and (3) Mechanical—in piston rings, valve seats, energy absorbing devices, cruise control parts, and bearing pads for the construction industry.

Fluoropolymers are also used in the aerospace and aircraft industry and more recently in medical and consumer markets. In the consumer field they are used to coat cookware, saw blades and also as components for such applications as coffee pots, urns, and toasters.

Suppliers of Granular PTFE Resins

Allied Chemical Corp.
American Hoechst Corp.
Custom Compounding
E.I. duPont de Nemours & Co.
ICI Americas
LNP Corporation
Mikro Technik
Montedison USA
Ugine Kuhlmann of America, Inc.

U.S. SALES OF FLUOROPOLYMER RESINS (GRANULAR TYPE ONLY)
(in thousands of pounds)

	1978	1979	1980	1981[r]	1982
Virgin, First Quality	6,976	7,819	7,310	7,699	5,651
Filled Resin, including colors	3,192	3,351	2,846	3,265	2,283
Miscellaneous lubricants, release compounds, etc.[1]	2,847	3,234	3,349	3,503	2,493
Total	13,015	14,404	13,505	14,467	10,427

[1] Includes broad specification second quality.
r = revised from 1982 edition.
Source: SPI's Fluoropolymers Division.

Compound Growth Rate
1977-1982

Virgin, First Quality	−1.7%
Filled resin, including colors	−5.4%
Miscellaneous lubricants, release compounds, etc.	−3.0%
Total	−2.9%

HIGH DENSITY POLYETHYLENE

Manufacturing

Known Manufacturers	Estimated Capacity as of December 31: (millions of pounds) 1982	1983
Allied Corp.	650	650
American Hoechst Corp.	220	250
Amoco Chemicals Corp.	340	340
ARCO Chemicals Co.	325	325
Chemplex Company	325	325
Conoco Chemicals Co.	—	865
Dow Chemical U.S.A.	400	400
DuPont, E.I. de Nemours & Co.[a]	425	—
Gulf Oil Chemicals	570	570
Hercules Incorporated	15	15
National Petrochemicals Corp.	550	550
Phillips Petroleum Co.	1,500	1,500
Soltex Polymers	750	750
Union Carbide Corp.	330	330
Total	6,400	6,910

[a]Business transferred to Conoco Chemicals Div. in 1983.

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

Production and Sales & Captive Use (millions of pounds)

Year	Production	Sales & Captive Use
1978	4,201	4,165
1979	5,010	4,893
1980	4,405	4,394
1981	4,695	4,683
1982	4,928	5,024
Compound Growth Rate 1977-1982	6.2%	7.2%

	Percent of Total U.S. Sales & Captive Use
1978	11.88
1979	12.64
1980	12.49
1981	12.67
1982	14.31

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

HIGH DENSITY POLYETHYLENE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Film (12 mils & below)	189	212	201	281	288
Sheet (over 12 mils)	55	66	55	52	64
Injection molding	802	1,074	938	997	1,102
Wire & cable	115	126	106	111	110
Extrusion coating	40	30	28	33	16
Blow molding	1,461	1,724	1,573	1,696	1,714
Pipe & conduit	344	400	369	408	395
Other extruded products	21	19	24	18	25
All other uses	647	634	573	626	633
Total	3,674	4,285	3,867	4,222	4,347

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	62	90	85	63	49
Packaging	1,865	2,190	2,049	2,367	2,565
Building/Construction	413	445	428	486	441
Electrical/Electronic	170	210	167	146	142
Furniture/Furnishings	12	14	*	*	*
Consumer & Institutional	488	496	495	482	421
Industrial/Machinery	52	106	*	102	95
Adhesives, Inks & Coatings	—	—	—	*	*
All Other	612	733	644	576	634
Exports	491	609	526	461	677
Total	4,165	4,893	4,394	4,683	5,024

*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

LATEX MATERIALS

Latex materials (sometimes referred to as emulsion polymers) are dispersions of the plastic polymer particles in water. Developed in the laboratory in the early 1930's, the first successful product was a synthetic rubber latex, commercialized during World War II to supplement the short supply of natural rubber latex.

A great variety and profusion of emulsions are now in commercial production. The most important of the plastic latexes are copolymers of styrene and butadiene, homopolymers and copolymers of vinyl acetate, acrylates, and vinyl chloride, as well as emulsions of polyvinyl chloride, polyvinylidene chloride, and other specialties. Other co-monomers used include fumarate, maleate, and ethylene.

The non-plastic synthetic rubber latices, excluded from SPI statistics, are elastomers categorized as Styrene/Butadiene (high butadiene), Polybutadiene, Acrylonitrile/Butadiene, Chloroprene, and Butyl. There is a significant amount of inter-product competition, particularly among the plastic types, and further there is competition with the synthetic and natural rubber latices which historically have been used.

The major end-uses for these plastic latex materials lie in four areas: (1) Adhesives—primarily in the packaging, construction, and wood products areas; (2) Coatings—primarily as a vehicle in water-based paints; (3) Paper—primarily as a clay coatings binder, but also used for saturating; and (4) Textiles—primarily as fabric finishes, sizes, back coats, and in fabric lamination and non-woven fiber bonding.

The emulsions and compounds are generally sold or used in relatively small batches (drums, tank trucks, and tank cars), and in many applications the emulsions are tailor-made to the end-use. There are thousands of end-users, some of whom polymerize for themselves, some of whom buy compounded material.

Each product sold has some unique characteristic desired in the end-use. For example, some adhesive resins should impart water resistance, fabric resins should be hard or soft depending on the type desired, and coatings resins should have good tint retention properties.

As a class these plastic emulsions have gained wide acceptance in the above mentioned end-uses for one or more of the following reasons:

—Water base (will meet the requirements of air pollution controls and regulations)
—Ease of clean-up
—Good adhesion to various substrates
—High pigment binding capacity
—Abrasion resistance and flexibility
—Uniform quality as compared with natural binders
—Good supply picture as compared with many of the natural binders
—Relative low cost versus binding efficiency
—Compatibility with existing technology and processes

Significant Producers*

Air Products & Chemicals	B.F. Goodrich Chemical	Polysar Corp.
American Synthetic Rubber	Goodyear Tire & Rubber	Reichhold Chemicals
Borden Chemical	W.R. Grace	Rohm and Haas
Dow Chemical	Monsanto Company	Union Carbide Corp.
DuPont	Morton Chemical	Union Chemical
H.B. Fuller Company	National Starch	U.S. Industrial Chemicals
General Tire & Rubber	Occidental Chemical	USS Chemicals

*Those producers in the SPI statistical report.

Production by product type and end-use is as follows:

Product Type	Approximate % of Total
Polyvinyl acetate homopolymers and copolymers	49
Styrene/butadiene polymers	44
All other	7
	100

End-Use	Approximate % of Total
Export	3
Domestic	97
Emulsion paint	16
Adhesives	21
Paper treating and coating	26
Textile and non-woven	7
Other	27
	100

STYRENE BUTADIENE & OTHER STYRENE BASED LATEXES

Styrene Butadiene Latexes are an outgrowth of the World War II development of GRS Latex used in the manufacture of synthetic rubber. The first large application was in the production of tablecloths in the late 1940's. About that time the first latex paint was introduced commercially. During the 1950's another large market developed, namely in coating formulations, clay, and in a variety of paper and paperboard products.

However, the largest market for SB Latexes developed in the 1960's. That was in the tufted rug industry, which was growing at that time at a rate of almost 20% per year. The advent of self-cure or carboxylated SB Latexes enabled the successful use of carpet-backing compounds.

Some other applications include non-woven binders, adhesives, textile inks, and in building products.

Significant producers are: Dow, General Tire & Rubber, Goodyear, W.R. Grace, Monsanto, Morton Industries, Occidental, Polysar, Reichhold, Union Chemical and USS Chemicals.

Production and Sales & Captive Use
(thousands of pounds)

		Sales & Captive Use				
Year	Production	Paper Treating	Textile Treating	Carpet Backing	All Other	Total
1978	722,264	79,511	29,739	347,860	261,797	718,907
1979	736,866	21,694	24,644	360,961	328,708	736,007
1980	631,816	27,445	24,734	293,059	286,805	632,043
1981	674,188	32,024	28,152	258,740	331,617	650,533
1982	510,160	24,211	12,829	199,461	267,760	504,261

Source: Monthly Statistical Report, SPI Committee on Resin Statistics as compiled by Ernst & Whinney.

LOW DENSITY POLYETHYLENE

Manufacturing

Known Manufacturers	Estimated Capacity as of December 31:[1] (millions of pounds) 1982	1983
ARCO Chemicals Co.[a]	300	—
Chemplex Company	400	400
Dow Chemical U.S.A.	1,400	1,400
DuPont, E.I. de Nemours & Co.	700	700
Eastman Chemical Products	400	550
El Paso Chemical Co.	550	550
Exxon Chemical U.S.A.	1,275	1,275
Gulf Oil Chemicals	900	900
Mobil Chemical Co.	500	750
Northern Petrochemical Company	560	560
Union Carbide Corp.	1,675	1,400
U.S. Industrial Chemicals Company	700	700
Total	9,360	9,185

[1]Includes Linear Low Density

[a]Closed down their plant in 1983.

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

Production and Sales & Captive Use
(millions of pounds)

Year	Production	Sales & Captive Use
1978	7,111	7,147
1979	7,793	7,815
1980	7,291	7,467
1981	7,693	7,516
1982	7,503	7,687
Compound Growth Rate 1977-1982	3.0%	3.4%

	Percent of Total U.S. Sales & Captive Use
1978	20.38
1979	20.19
1980	21.22
1981	20.34
1982	21.89

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

LOW DENSITY POLYETHYLENE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Film (12 mils & below)	4,018	4,363	4,004	4,077	4,209
Sheet (over 12 mils)	28	26	18	14	18
Injection molding	601	650	519	524	507
Wire & cable	422	424	335	347	278
Extrusion coating	489	539	517	564	544
Blow molding	56	60	65	60	42
Pipe & conduit	26	33	22	25	23
Other extruded products	68	80	56	60	46
All other uses	682	742	784	862	876
Total	6,390	6,917	6,320	6,533	6,543

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	55	56	*	53	*
Packaging	4,462	4,796	4,582	4,602	4,623
Building/Construction	233	245	186	148	225
Electrical/Electronic	492	500	416	431	345
Furniture/Furnishings	*	*	15	15	*
Consumer & Institutional	681	672	570	598	487
Industrial/Machinery	*	*	*	*	*
Adhesives, Inks & Coatings	55	27	*	*	46
All Other	412	621	551	685	817
Exports	757	898	1,147	984	1,144
Total	7,147	7,815	7,467	7,516	7,687

*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

NYLON

Manufacturing

Known Manufacturers	Estimated Capacity as of December 31: (millions of pounds) 1982	1983
Adell Plastics, Inc.	14	14
Allied Corp.	70	80
American Hoechst Corp.	16	16
Badische Corp.	15	15
Belding Chemical Industries	3	3
Celanese Engineering Resins Co.	40	40
Custom Resins, div. Bemis Co.	18	18
DuPont, E.I. de Nemours & Co.	150	150
Emser Industries	10	10
Firestone Fibers & Textiles Co.	12	—
Monsanto Company	65	65
Rilsan Corp.	15	15
Shakespeare Co.	4	4
Wellman, Inc.	8	8
Total	440	438

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

Production and Sales & Captive Use
(millions of pounds)

Year	Production	Sales & Captive Use
1978	275	278
1979	327	315
1980	274	271
1981	312	288
1982	228	247
Compound Growth Rate 1977-1982	−2.1%	−0.2%

	Percent of Total U.S. Sales & Captive Use
1978	0.79
1979	0.81
1980	0.77
1981	0.78
1982	0.70

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

NYLON
DOMESTIC CONSUMPTION BY END-USE
(in thousands of pounds)

End-use	1978	1979	1980	1981	1982
Automotive and truck	93,494	100,878	77,972	89,115	69,909
Electrical and Electronic[1]	29,348	42,691	34,792	32,857	28,870
Appliances	14,070	14,684	7,061	8,549	6,847
Film and Coating	20,631	24,202	27,918	28,740	31,879
Wire and Cable	12,755	15,500	16,824	18,999	15,898
Monofilament	8,089	11,417	11,928	15,593	10,126
Consumer[2]	15,954	19,569	21,120	16,533	14,967
Others	62,714	56,414	50,434	59,159	52,029
Total	257,055	285,355	248,049	269,545	230,525

[1]Includes electrical and electronic applications not assignable to automotive and truck or appliance markets.
[2]Includes such items as housewares, brushes, combs, sporting goods, cameras and toys.

Source: SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	99	96	81	92	74
Packaging	24	31	28	32	33
Building/Construction	3	9	*	*	*
Electrical/Electronic	55	59	53	57	50
Furniture/Furnishings	*	*	8	8	*
Consumer & Institutional	16	15	17	17	13
Industrial/Machinery	19	26	20	26	21
Adhesives, Inks & Coatings	*	*	*	*	*
All Other	41	50	41	37	38
Exports	21	29	23	19	18
Total	278	315	271	288	247

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYPROPYLENE

Manufacturing

Known Manufacturers	Estimated Capacity as of December 31: (millions of pounds) 1982	1983
Amoco Chemicals	550	550
ARCO Chemicals Co.	400	400
Eastman Chemical Products, Inc.	140	140
El Paso Chemical Co.	275	275
Exxon Chemical U.S.A.	375	395
Gulf Oil Chemicals Company	400	400
Hercules Incorporated	1,250	1,250
Northern Petrochemical Company	200	200
Phillips Petroleum Company	200	200
Shell Chemical Company	600	600
Soltex Polymer Corp.	200	200
USS—Novamont Corp.	500	500
Total	5,090	5,110

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

Production and Sales & Captive Use (millions of pounds)

Year	Production	Sales & Captive Use
1978	3,074	3,055
1979	3,841	3,894
1980	3,648	3,714
1981	3,955	3,888
1982	3,477	3,623
Compound Growth Rate 1977-1982	4.8%	6.1%

	Percent of Total U.S. Sales & Captive Use
1978	8.71
1979	10.06
1980	10.56
1981	10.52
1982	10.32

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYPROPYLENE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Injection molding, total	1,062	1,219	1,119	1,243	1,073
Appliances	93	99	87	94	72
Consumer products	178	278	301	359	273
Rigid packaging	185	208	225	266	291
Transportation	392	350	252	247	225
All other injection molding	214	284	254	277	212
Blow molding	59	62	63	65	68
Film (10 mils & below)	239	282	298	303	290
Sheet	29	31	36	35	19
Other extruded products (including wire & cable, pipe & conduit, and extrusion coating)	79	97	84	99	93
Fiber & filaments	852	1,020	963	1,036	866
All other uses	371	469	472	421	476
Total	2,691	3,180	3,035	3,202	2,885

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	322	260	230	266	199
Packaging	477	722	[illegible]	812	757
Building/Construction	*	*	*	*	31
Electrical/Electronic	215	210	196	248	161
Furniture/Furnishings	564	759	727	813	772
Consumer & Institutional	518	539	505	487	421
Industrial/Machinery	34	54	52	56	*
Adhesives, Inks & Coatings	*	*	*	*	*
All Other	561	636	604	521	545
Exports	364	714	680	685	737
Total	3,055	3,894	3,714	3,888	3,623

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYSTYRENE

Manufacturing

Known Manufacturers	Estimated Capacity as of December 31: (millions of pounds) 1982	1983
A & E Plastic Pak	30	30
American Hoechst Corp.	600	600
Amoco Chemicals Corp.	400	400
ARCO Chemicals Co.	450	450
Asoma Chemicals, Inc.	—	90
BASF Wyandotte Corp.	180	180
Cosden Oil & Chemical Company	450	450
Dart Container	—	50
Dow Chemical Corp.	1,000	1,000
Carl Gordon Industries[a]	100	—
Gulf Oil Chemicals	300	425
Huntsman Chemical Co.	—	300
Huntsman-Goodson Chemical Co.[b]	20	20
Kama Corp.	30	30
Mobil Chemical Corp.	200	450
Monsanto Company	750	750
Polysar Group	375	375
Shell Chemical Company[c]	300	—
Texstyrene Plastics Co.	10	10
Vititek	5	5
Total	5,200	5,615

[a] Sold business to Asoma and Dart Container in 1983.
[b] Company reorganized in 1983 with name change.
[c] Sold business to Huntsman Chemical in 1983.
Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

Production and Sales & Captive Use (millions of pounds)

Year	Production	Sales & Captive Use
1978	3,823	3,870
1979	4,005	3,997
1980	3,521	3,518
1981	3,621	3,604
1982	3,191	3,200
Compound Growth Rate 1977-1982	−1.5%	−2.1%

	Percent of Total U.S. Sales & Captive Use
1978	11.04
1979	10.32
1980	10.00
1981	9.75
1982	9.11

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYSTYRENE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Straight Polystyrene	1,828	1,906	1,761	1,793	1,669
Rubber-Modified Polystyrene	2,042	2,091	1,757	1,811	1,531
Total	3,870	3,997	3,518	3,604	3,200
Molding	1,814	1,901	1,596	1,638	1,368
Extrusion	1,245	1,314	1,083	1,142	1,060
Expandable Polystyrene Beads	407	445	431	416	426
All Other Uses	247	175	240	257	251
Total Domestic	3,713	3,835	3,350	3,453	3,105

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	21	23	13	16	4
Packaging	1,401	1,424	1,349	1,494	1,288
Building/Construction	320	350	277	273	289
Electrical/Electronic	375	383	301	360	311
Furniture/Furnishings	129	118	74	62	39
Consumer & Institutional	876	927	779	756	745
Industrial/Machinery	26	26	*	*	*
Adhesives, Inks & Coatings	—	—	*	*	*
All Other	566	585	557	493	429
Exports	156	161	168	150	95
Total	3,870	3,997	3,518	3,604	3,200

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYVINYL CHLORIDE

Manufacturing

Known Manufacturers	Estimated Capacity as of December 31: (millions of pounds) 1982	1983
Air Products & Chemicals	150	150
Borden Chemical Company, The	500	600
Certain-Teed Products Corp.	220	220
Conoco Chemicals	715	715
Ethyl Corp.	315	315
Formosa Plastics	700	740
General Tire & Rubber Company	120	120
Georgia-Pacific Corp.	700	700
B.F. Goodrich Chemical Company, The	1,700	1,850
Goodyear Tire & Rubber Company, The	70	70
Keysor-Century Corp.	50	50
Occidental Chemical Co.	600	500
Pantasote Co. of New York, The	50	—
Shintech, Inc.	600	600
Tenneco Chemicals	900	900
Union Carbide Corp.	145	145
Total	7,535	7,775

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

Production and Sales & Captive Use (millions of pounds)

Year	Production	Sales & Captive Use
1978	5,723	5,810
1979	6,119	6,138
1980	5,470	5,407
1981	5,707	5,601
1982	5,326	5,455
Compound Growth Rate 1977-1982	0.3%	0.8%

	Percent of Total U.S. Sales & Captive Use
1978	16.57
1979	15.85
1980	15.37
1981	15.16
1982	15.54

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYVINYL CHLORIDE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

End-use	1978	1979	1980	1981	1982
Calendering, total	667	719	623	666	594
Flooring	153	173	138	147	149
Textile	146	110	94	73	64
All other calendering	368	436	391	446	381
Coating, total	532	489	370	314	267
Flooring	181	186	125	123	99
Textile & paper coating	141	138	119	100	87
Protective coatings	123	83	67	41	38
Adhesives & all other coatings	87	82	59	50	43
Extrusion, total	3,254	3,514	2,978	3,149	3,129
Wire & cable	400	409	368	367	328
Film & sheet	255	292	253	287	312
Rigid pipe & tubing (except fittings)	2,099	2,323	1,865	2,033	2,014
All other extrusions	500	490	492	462	475
Molding, total	535	503	415	372	364
Bottles	94	82	98	92	103
Sound records	211	160	114	104	112
Fittings (rigid pipe & tubing)	117	113	92	102	99
All other molding	113	148	111	74	50
Paste processes (except coating), total	169	184	154	182	172
Plastisol formulation	88	93	81	99	85
All other	81	91	73	83	87
Resellers	89	76	86	140	147
All other uses	321	331	316	342	217
Grand total	5,567	5,816	4,942	5,165	4,890

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

Major Market	1978	1979	1980	1981	1982
Transportation	278	270	195	177	123
Packaging	394	525	410	424	450
Building/Construction	3,150	3,167	2,690	2,891	2,902
Electrical/Electronic	643	623	530	583	467
Furniture/Furnishings	300	320	216	171	236
Consumer & Institutional	428	485	427	434	356
Industrial/Machinery	23	38	16	19	*
Adhesives, Inks & Coatings	103	92	79	56	*
All Other	248	296	370	410	355
Exports	243	322	465	436	566
Total	5,810	6,138	5,407	5,601	5,455

*Included in all other.
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYVINYL ACETATE

Polyvinyl acetate is produced by the emulsion polymerization of vinyl acetate to yield a water emulsion with a solids content of 50-55%. Commercial exploitation of this polymer began in the early 1930's, although its discovery dates from the early 1900's. Early production of the resin was primarily as a homopolymer, but more recently resin properties have been changed by including comonomers as n-butyl acrylate, 2-ethylhexyl acrylate, ethylene, dibutylmaleate, and dibutyl fumarate. Because of the large number of polyvinyl acetate producers, the numerous copolymers included and the variety of physical forms, polyvinyl acetate production is reported to SPI in terms of vinyl acetate monomer sold to or used by the polymerizer.

Polyvinyl acetate resins are primarily used in aqueous emulsions and find utility in adhesives, paints, textile finishes, and paper coating applications. A typical example of a polyvinyl acetate emulsion is the "white glue" used in many homes and schools.

There are more than 50 producers of polyvinyl acetate, supplied with monomer by such companies as Borden, Celanese Chemical, DuPont, National Starch, Union Carbide, and U.S. Industrial Chemicals.

SALES AND CAPTIVE USE OF VINYL ACETATE MONOMER FOR POLYVINYL ACETATE (thousands of pounds)

Year	Emulsion Paint	Adhesives	Paper	Textile	Non-woven Binders	Others	Export	Total
1978	237,915	280,573	85,268	25,284	23,102	41,811	16,216	710,169
1979	287,617	257,520	87,627	28,935	30,062	46,513	20,782	759,056
1980	224,587	262,431	88,372	33,014	30,991	43,292	18,306	700,993
1981	179,531	263,205	85,465	26,666	29,865	42,357	14,557	641,646
1982	163,470	234,994	94,185	17,250	25,700	26,143	6,081	567,823

Compound Growth Rate Total Sales & Captive Use	
1977-1982	−3.5%
1981-1982	−11.5%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYVINYL ALCOHOL

Polyvinyl alcohol was first prepared by Herrman and Haehnel in Germany in 1924 with commercial production beginning in the U.S. in the early 1930's. Polyvinyl alcohol is a unique polymer in that its monomer, vinyl alcohol, does not exist. It is produced from polyvinyl acetate by hydrolysis in either a batch or continuous process. This reaction can be controlled so that any degree of replacement of the acetate groupings can be produced. The degree of hydrolysis affects the resin properties such as water solubility, solvent resistance, adhesive strength, and other properties. Polyvinyl alcohol is primarily used as the fully-hydrolyzed product.

The principal uses of polyvinyl alcohol are in textile warp sizing, adhesive manufacture, as a suspending aid in polymerization, paper coatings, as an intermediate in the manufacture of polyvinyl butyral and in a variety of minor applications ranging from cosmetic manufacture to soil erosion control. The major manufacturers of polyvinyl alcohol in the U.S. are DuPont, Air Products, and Monsanto.

Production and Sales & Captive Use
(thousands of pounds)

		Sales & Captive Use		
Year	Production	Domestic	Export	Total
1977	119,217	112,997	5,262	118,259
1978	126,967	119,882	13,359	133,241
1979	147,702	123,857	24,451	148,308
1980	140,619	115,177	13,151	128,328
1981	138,898	114,355	20,393	134,748
1982	*	*	*	*

*Series discontinued due to insufficient number of reporting companies.

Compound Growth Rate Total Sales & Captive Use	
1976-1981	4.2%
1980-1981	5.0%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

OTHER VINYL RESINS

Vinyl resins included in this category are polyvinyl butyral, polyvinyl formal, and polyvinylidene chloride and their respective copolymers containing at least 50% of the base resin.

Polyvinyl butyral and polyvinyl formal are prepared by reacting polyvinyl alcohol with butyraldehyde or formaldehyde in the presence of a strong mineral acid. There are many grades of these products in use, differing in degree of hydroxyl substitution and molecular weight. The largest end use of polyvinyl butyral is as the adhesive film in the lamination of auto safety glass. The major use of polyvinyl formal is in magnet wire coatings.

Polyvinylidene chloride is prepared by suspension or emulsion polymerization of vinylidene chloride. It finds major application as a film or as a coating on flexible substrates for packaging food products where oxygen impermeability and oil resistance are important.

Producers of these vinyl resins include Dow, DuPont, B.F. Goodrich, W.R. Grace, Monsanto, Morton Industries, Rohm and Haas, Union Carbide and Union Chemical.

Production and Sales & Captive Use
(thousands of pounds)

Year	Production	Sales & Captive Use
1978	196,742	190,763
1979	220,154	212,779
1980	196,235	192,638
1981	208,201	198,903
1982	177,225	166,695

Compound Growth Rate of Sales & Captive Use

1977-1982	−3.0%
1981-1982	−16.2%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

MISCELLANEOUS THERMOPLASTICS
(millions of pounds)

Resin	Production				
	1977	1978	1979	1980	1981
Acrylics	987	1,086	1,142	1,028	1,100
Cellulosics	356	468	480	n.a.	n.a.
Petroleum hydrocarbons	334	319	321	264	272
Non-nylon polyamides	41	33	35	46	49
Polyterpenes	14	15	30	41	36
Rosin modifications	47	41	94	182	275
Other[1]	115	169	188	406	607

Resin	Sales				
	1977	1978	1979	1980	1981
Acrylics	n.a.	n.a.	n.a.	n.a.	884
Cellulosics	228	n.a.	333	n.a.	n.a.
Petroleum hydrocarbons	332	309	301	253	259
Non-nylon polyamides	40	33	34	42	47
Polyterpenes	14	15	30	36	35
Rosin modifications	47	42	85	177	266
Other[1]	862	883	667	791	806

n.a. = not available

[1]Includes acrylic (sales only 1977-1980), chlorinated polyolefins, coumarone-indene, fluoropolymers, polybutylene.
polyphenyl aromatic esters, and other thermoplastics. Cellulosics also included in 1978, 1980 & 1981.

Source: *Synthetic Organic Chemicals*, U.S. International Trade Commission.

DOMESTIC SALES & USE OF SELECTED THERMOPLASTICS BY PROCESS GRADE
(millions of pounds)

Material/Year	Total	Injection Molding	Extrusion	Blow Molding	Other
Grand Total					
1978	23,373	5,354	12,149	1,670	4,200
1979	25,443	6,010	13,143	1,928	4,362
1980	22,621	5,078	11,631	1,799	4,113
1981	23,693	5,233	12,245	1,913	4,302
1982	22,688	4,879	11,655	1,927	4,227
Growth Rate					
1977-1982	1.4%	−0.5%	1.4%	6.0%	1.9%
Polyolefins					
1978	12,755	2,465	7,014	1,576	1,700
1979	14,382	2,943	7,748	1,846	1,845
1980	13,222	2,576	7,116	1,701	1,829
1981	13,957	2,764	7,463	1,821	1,909
1982	13,775	2,682	7,284	1,824	1,985
Growth Rate					
1977-1982	3.7%	3.4%	2.8%	6.0%	6.3%
LD Polyethylene					
1978	6,390	601	5,051	56	682
1979	6,917	650	5,465	60	742
1980	6,320	519	4,952	65	784
1981	6,533	524	5,087	60	862
1982	6,543	507	5,118	42	876
Growth Rate					
1977-1982	2.1%	−3.4%	1.9%	−4.9%	7.7%
HD Polyethylene					
1978	3,674	802	764	1,461	647
1979	4,285	1,074	853	1,724	634
1980	3,867	938	783	1,573	573
1981	4,222	997	903	1,696	626
1982	4,347	1,102	898	1,714	633
Growth Rate					
1977-1982	6.8%	10.1%	7.3%	6.4%	2.5%
Polypropylene					
1978	2,691	1,062	1,199	59	371
1979	3,180	1,219	1,430	62	469
1980	3,035	1,119	1,381	63	472
1981	3,202	1,243	1,473	65	421
1982	2,885	1,073	1,268	68	476
Growth Rate					
1977-1982	3.6%	1.6%	3.4%	6.3%	9.5%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney. Industry contacts.

DOMESTIC SALES & USE OF SELECTED THERMOPLASTICS BY PROCESS GRADE (Cont'd.)
(millions of pounds)

Material/Year	Total	Injection Molding	Extrusion	Blow Molding	Other
A B S					
1978	1,081	498	356	—	227
1979	1,124	586	302	—	236
1980	859	471	208	—	180
1981	848	488	180	—	180
1982	689	430	111	—	148
Growth Rate 1977-1982	−7.7%	−3.5%	−18.0%	—	−7.3%
Polystyrene					
1978	3,713	1,814	1,245	—	654
1979	3,836	1,901	1,314	—	621
1980	3,350	1,596	1,083	—	671
1981	3,453	1,638	1,142	—	673
1982	3,105	1,368	1,060	—	677
Growth Rate 1977-1982	−2.0%	−4.5%	−1.3%	—	2.7%
Nylon					
1978	257	179	57	—	21
1979	285	195	67	—	23
1980	248	169	74	—	5
1981	270	178	76	—	16
1982	229	138	71	—	20
Growth Rate 1977-1982	−0.4%	−3.3%	4.5%	—	7.4%
P V C					
1978	5,567	441	3,254	94	1,778
1979	5,816	421	3,514	82	1,799
1980	4,942	317	2,978	98	1,549
1981	5,165	280	3,149	92	1,644
1982	4,890	261	3,129	103	1,397
Growth Rate 1977-1982	−0.4%	−3.3%	1.7%	6.5%	−4.1%

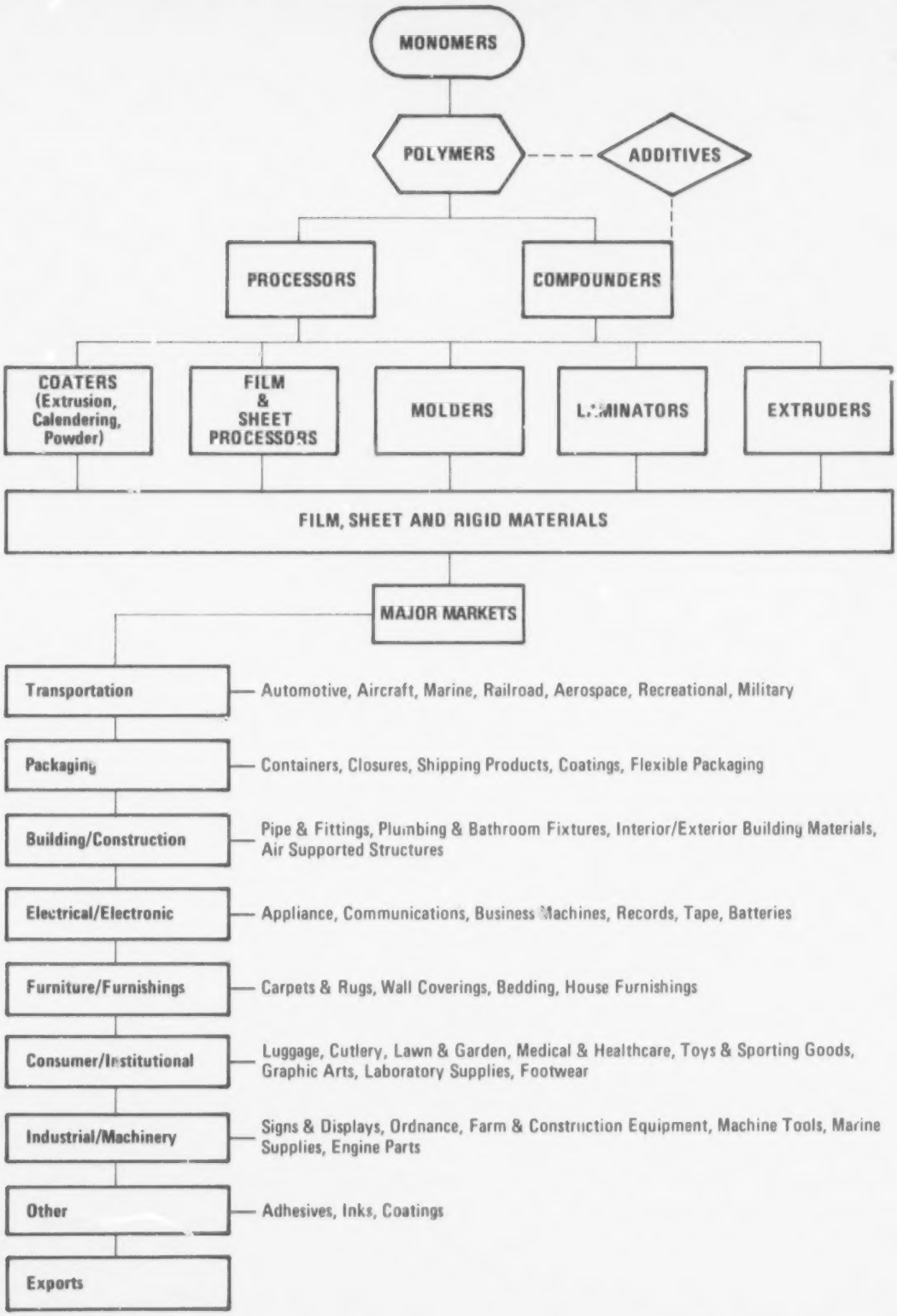
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney. Industry contacts.

Courtesy: Celanese Engineering Resins Co. and *Plastics World Magazine*

Pasta Maker made of Acetal copolymer.

FABRICATED PLASTIC PRODUCTS

FLOW CHART: FROM RAW MATERIAL TO FINAL PRODUCT



Source: SPI, Committee on Resin Statistics, *Major Markets Manual.*

REINFORCED PLASTICS

The combination of thermosetting unsaturated polyester resins with glass fiber accounts for the bulk of reinforced plastics products. Phenolics, vinyl esters, epoxies and fumarate resins bring thermosets' share of the market to almost 90%. The thermoplastics which account for the remainder, in general relative importance, are polyolefins, nylon, polycarbonate, styrenics, and polyvinyl chloride.

Random glass fibers are the volume reinforcement, but beads, flake, and woven mat and roving are other forms in which the glass may be used. For very high-performance or unique applications such as required in aerospace parts, or sporting goods shafts, carbon and graphite or certain synthetic fibers have a growing use experience. By weight the reinforcement is usually 25-35%, but 50% is not unusual in spray-up or press-molded materials.

Thermoset materials have been the choice for impact-strength, higher resistance to heat distortion, and resistance to corrosive environments. Thermoplastics are developing where large runs of uniform parts are a requirement, and where relatively smaller size of the parts makes processing feasible. In the last two years the reinforcement of foamed parts has become a reality in several markets.

Reinforced plastics production at the outset, during World War II, was almost entirely for military use such as in radomes. In recent years the marine market has dominated consumption, but even though its projected growth is 75% over the next five years it will probably soon take second place to transportation. The use of RP in automobiles could double over the next four years. The other high-volume growth market in the immediate future is chemical-resistance and pipeline application. All of the use categories for reinforced plastics are slated for faster growth than the economy generally.

The reinforced plastics industry enjoys a high level of technical activity because of the engineered nature of its products, and the relatively high value-added nature of the finished product. The search for new applications is vigorous, while new levels of performance in existing uses are continually being refined. Environmental and health concerns about styrene monomer, as well as continued demands of fire-retardant and non-toxic materials, suggest that research on basic resin characteristics will also continue.

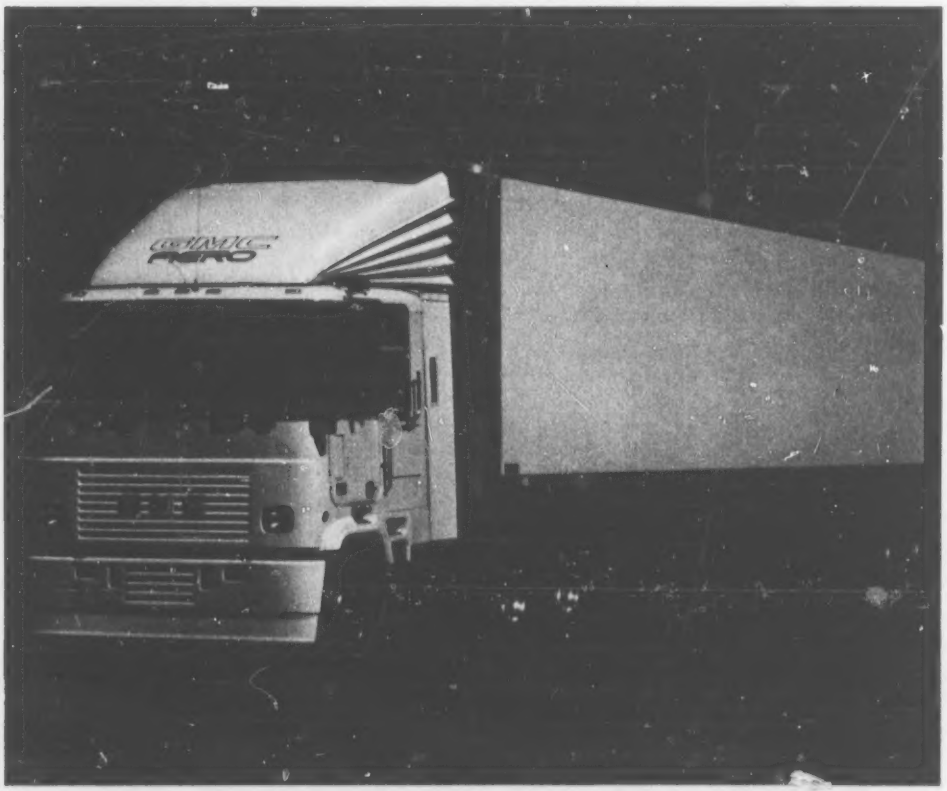
The structure of the reinforced plastics industry has stabilized in recent years. Several materials suppliers have, in the pattern of other domestic industries, "integrated forward" by acquiring or developing fabrication divisions which specialize in a given manufacturing process or market, such as panels for light construction, corrosion-resistant equipment, or sanitaryware. More common, however, has been the development by large corporations identified with a given market, such as industrial pipe, automotive parts, or marine equipment, of a "captive" reinforced plastics operation which complements or replaces their metal or woodworking manufacturing. In the last decade custom molders have attempted to stabilize their role by selecting to produce several types of parts which they handle especially well, but spreading these selections over several market areas to minimize uneven business cycles. There have, of course, emerged large and small manufacturing companies who independently specialize in a given process or product. To complete the picture of the RP industry's diversity, we must mention that there is still room for the inventor/entrepreneur and, at the other end of the development process, there continues to be a considerable degree of university and laboratory research.

REINFORCED PLASTICS SHIPMENTS BY MARKET
(Both Thermoset & Thermoplastic Resins)

	Shipments (in millions of pounds)					
Markets	**1978**	**1979**	**1980**	**1981**	**1982[1]**	**1983[2]**
Aircraft & Aerospace	22	23	25	28	22	25
Appliances & Equipment	123	130	104	117	82	84
Construction	323	335	287	317	312	330
Consumer Goods	116	126	103	115	84	97
Corrosion-Resistant Products	216	238	252	275	235	252
Electrical Rods, Tubes, Parts	170	190	162	178	140	161
Marine & Marine Accessories	430	385	275	290	230	235
Land Transportation	532	550	416	445	359	402
Miscellaneous	74	79	70	75	64	70
Total	2,006	2,056	1,694	1,840	1,528	1,656

[1] = estimate
[2] = forecast

Source: SPI's Reinforced Plastics/Composites Institute.



Courtesy: General Motors and *Plastics World Magazine*

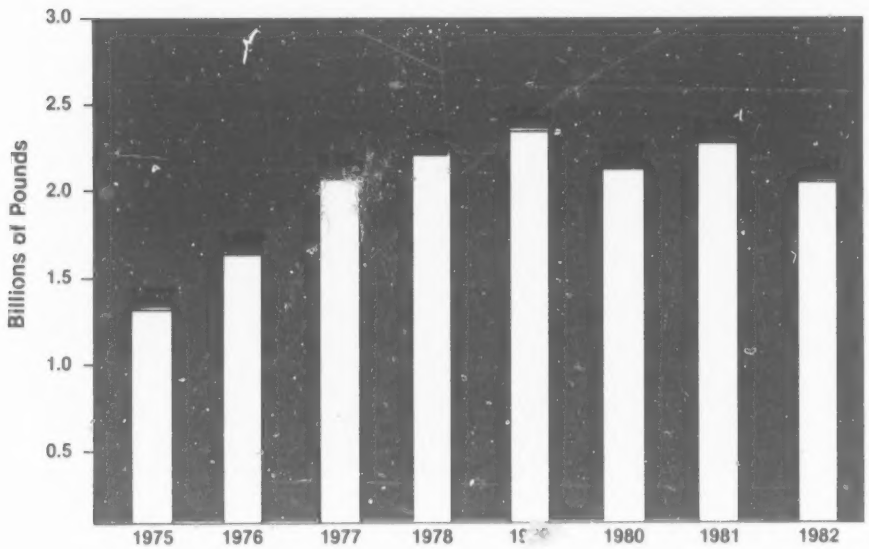
Aero Astro truck with six front-end fascia components processed by RRIM

PLASTICS PIPE AND FITTINGS

In 1982, overall shipments of thermoplastic pipe and fittings declined 9% as compared with 1981. Plastic pipe consumption declined 9.1% while fittings were down 6.5%. All figures exclude corrugated polyethylene pipe.

Plastics pipe shipments decreased to 2.0 billion pounds from 2.1 billion pounds in 1981. Plastics fittings volume dropped to 140 million pounds in 1982 versus 149 million pounds the year earlier.

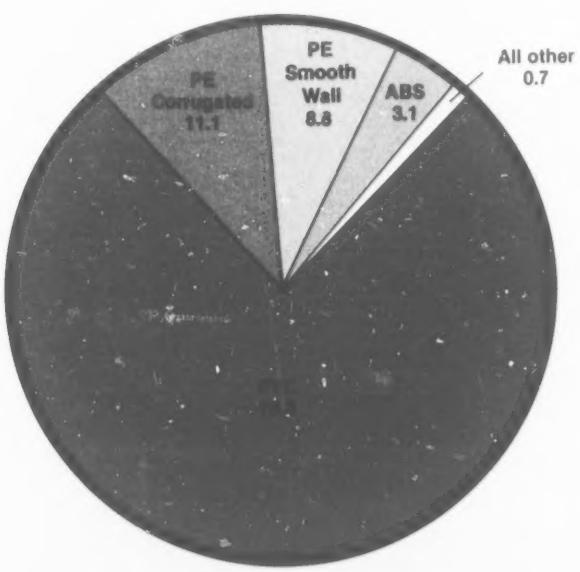
U.S. PLASTICS PIPE AND FITTINGS SHIPMENTS 1975-1982



Source: SPI Monthly Thermoplastics Pipe & Fittings Report, as compiled by Ernst & Whinney.

Market Share

Polyvinyl chloride (PVC) enjoyed by far the largest share of all plastics materials going into pipe and fittings applications. In 1982 PVC accounted for 76.3% of all pipe shipments. This was slightly more than PVC's share of a year earlier when it had 72.6%. The chart below shows the 1982 distribution of plastics pipe shipments by material. Corrugated polyethylene pipe is estimated at 250 million pounds in 1982.



U.S. SHIPMENTS OF THERMOPLASTIC PIPE, TUBE & CONDUIT BY MATERIAL
(in millions of pounds)

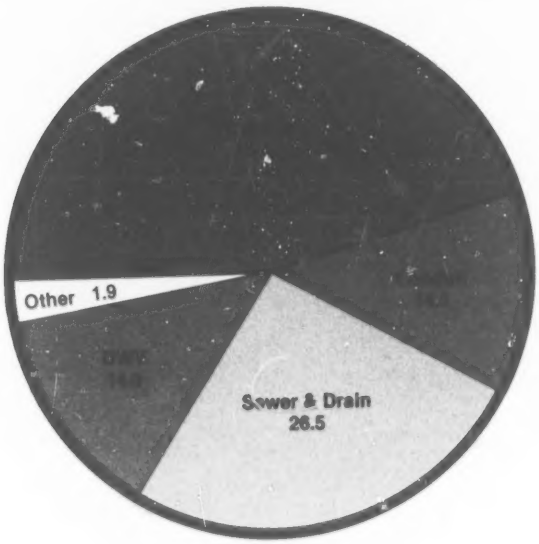
Year	Total	PVC	ABS	PE[1]	Other
1978	2,114	1,765	180	156	13
1979	2,254	1,860	185	197	12
1980	2,085	1,713	125	235	12
1981	2,202	1,834	97	256	15
1982	2,002	1,719	71	197	15
Growth Rate 1977-1982	0.1%	1.3%	−19.6%	4.9%	1.4%

[1]Excludes corrugated

U.S. PLASTIC PIPE SHIPMENTS BY MATERIAL 1982 vs 1981
(in millions of pounds)

Material	1982	1981	Change	% Change
PVC	1,719	1,834	−115	−6.3%
ABS	71	97	−26	−26.8
PE (Smooth wall)	197	256	−59	−23.0
Other	15	15	—	—
Total	2,002	2,202	−200	−9.1%

DISTRIBUTION OF PLASTICS PIPE SHIPMENTS BY APPLICATION—1982

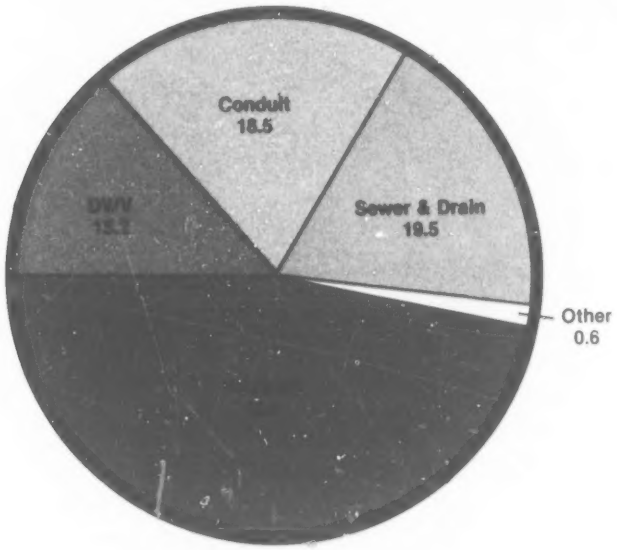


U.S. SHIPMENTS OF THERMOPLASTIC PIPE, TUBE & CONDUIT BY APPLICATIONS
(in millions of pounds)

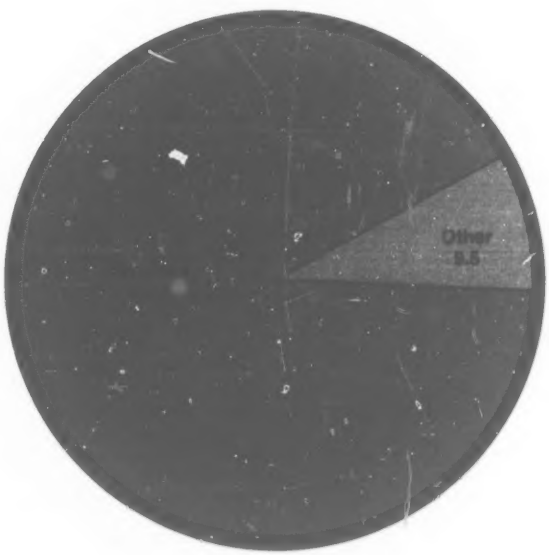
Year	Total	Pressure	Conduit	DWV	Other
1978	2,114	962	358	329	465
1979	2,254	1,058	406	313	477
1980	2,085	1,048	370	289	378
1981	2,202	1,130	370	289	413
1982	2,002	980	318	314	390
Growth Rate 1977-1982	0.1%	0.2%	3.5%	– 3.1%	0.3%

DWV = Drain, Waste & Vent

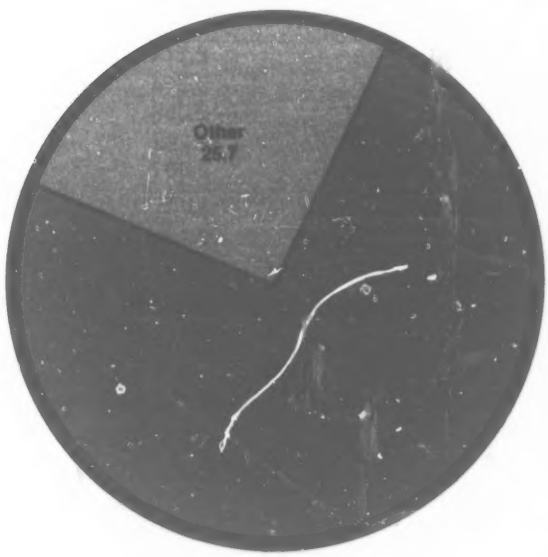
DISTRIBUTION OF PVC PIPE SHIPMENTS BY APPLICATION—1982



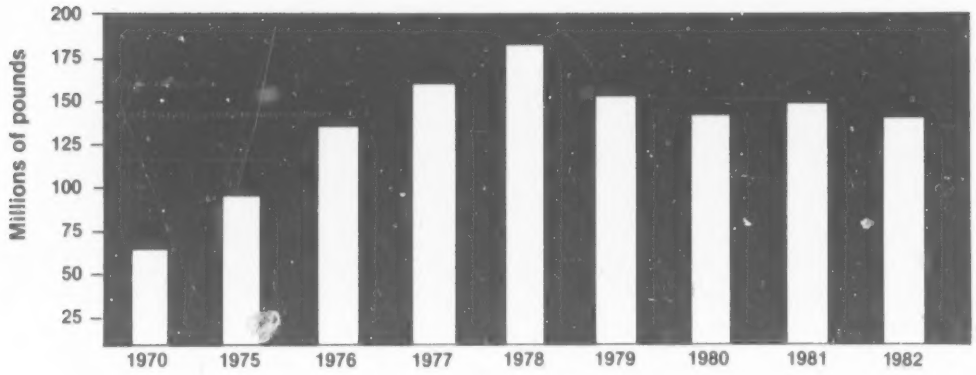
DISTRIBUTION OF POLYETHYLENE PIPE SHIPMENTS BY APPLICATION—1982



DISTRIBUTION OF ABS PIPE SHIPMENTS BY APPLICATION—1982



U.S. PLASTICS FITTINGS SHIPMENTS: 1970-1982



Source: SPI Monthly Thermoplastic Pipe & Fittings Report, as compiled by Ernst & Whinney.

U.S. PLASTICS FITTINGS SHIPMENTS BY MATERIAL
(millions of pounds)

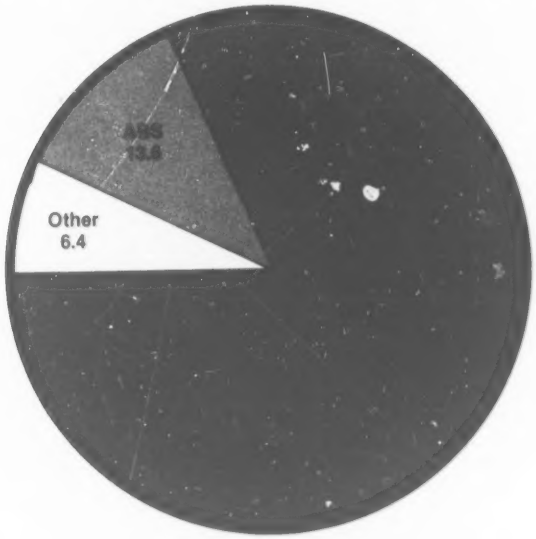
Year	Total	PVC	ABS	Other*
1978	187	118	59	10
1979	157	109	38	10
1980	142	103	30	9
1981	149	113	26	10
1982	140	112	19	9
Growth Rate 1977-1982	– 3.0%	1.7%	– 18.3%	2.4%

*Includes polyethylene, chlorinated PVC, polyacetal, etc.

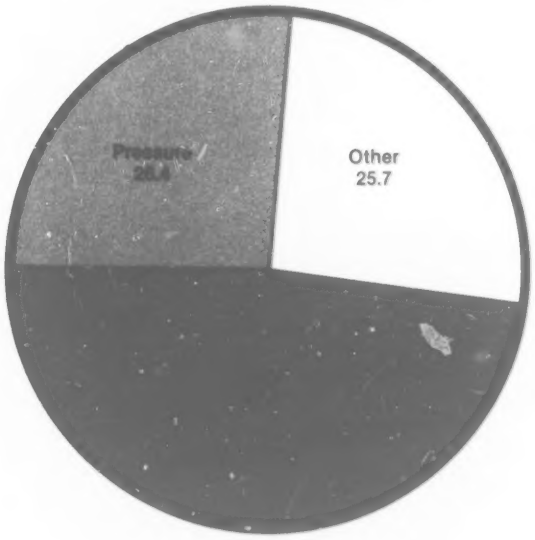
U.S. PLASTICS FITTINGS BY APPLICATION
(in millions of pounds)

Year	Total	Pressure	DWV	Other Non-Pressure
1978	187	32	117	38
1979	157	36	81	40
1980	142	34	68	40
1981	149	38	69	42
1982	140	37	67	36
Growth Rate 1977-1982	– 3.0%	5.7%	– 8.4%	3.0%

DISTRIBUTION OF PLASTICS FITTINGS BY MATERIAL-1982



DISTRIBUTION OF PLASTICS FITTINGS BY APPLICATION—1982



MAJOR MARKETS

DEFINITIONS

The primary product groups for each Major Market category are listed below:

A. TRANSPORTATION

Motor Vehicles and Parts: including autos, trucks, buses, motorcycles, and bicycles. Ships, boats and recreational vehicles.

All Other: including railroad equipment, travel trailers, campers, golf carts, snowmobiles, aircraft, military vehicles.

B. PACKAGING

Bottles, Jars, Vials

Food Containers: including disposable cups

Blister and Bubble Containers

Flexible Packaging: including household and institutional refuse bags and film

All Other: including tubes, tape, strapping, drums, caps, baskets, trays, boxes. pallets, shipping crates, pails, buckets, shipping cases.

C. BUILDING AND CONSTRUCTION

Pipe, Conduit and Fittings: including drainage, irrigation, plumbing fixtures, septic tanks

Building Material for all Structures: including siding, flooring, and insulation materials

All Other: including panels, doors, windows, skylights, bathroom units, gratings and railings.

D. ELECTRICAL AND ELECTRONIC

Home and Industrial Appliances: including electrical industrial equipment, wire and cable coverings, communications equipment

Electronic Components: including resistors, magnetic tape, records, and batteries.

E. FURNITURE AND FURNISHINGS

Rigid and Flexible Types: including household and office furniture, bedding, carpets, rugs, backing, curtains, blinds, awnings, lamps, picture frames, wall coverings.

F. CONSUMER AND INSTITUTIONAL PRODUCTS

Dinner and Kitchenware: including picnicware

Toys and Sporting Goods

Health Care and Medical Products: including laboratory supplies

Hobby and Graphic Arts Supplies: including photographic equipment and supplies

All Other: including footwear, luggage, buttons, lawn & garden tools, signs and displays, credit cards.

G. INDUSTRIAL/ MACHINERY

All Types: including engine and turbine parts, farm and garden machinery, construction and related equipment, machine tools, ordnance and firearms, chemical process equipment.

H. ADHESIVES/INKS/COATINGS

Adhesives and Sealants

All Other: including printing ink, magnet wire enamels, core binders, foundry facings, paper coating and glazing, paints, varnishes, and enamels.

I. RESELLERS/COMPOUNDERS

Sales of Resins Sold to Resellers, Compounders, Converters.

Unclassified Sales: including calenderers whose end-use markets cannot be ascertained by the resin supplier, or resin that cannot be classified under any of the Major Market categories listed above.

J. EXPORTS

Sales of Plastic Resin exported from the U.S.

1982 RESULTS

The 1982 data reflect major market plastics resins sales and captive use data compiled by Ernst & Whinney with consumption data being reported by individual resin. The plastics resins categories included in this study are:

THERMOSETS

Epoxy
Polyester, Unsaturated
Urea and Melamine
Phenolic
All Other Thermosets

THERMOPLASTICS

Low Density Polyethylene
High Density Polyethylene
Polypropylene
Acrylonitrile-Butadiene-Styrene (ABS) and Styrene-Acrylonitrile (SAN)
Polystyrene
Styrene Butadiene Latexes (SBL), and Other Styrene Based Latexes (OSBL), and Other Styrene Based Polymers (OSBP)
Nylon
Polyvinyl Chloride
Thermoplastic Polyester
All Other Thermoplastics

In addition, sales and captive use of polyurethane are reported separately by Major Market total only in an appendix to this report.

COMPARISON OF 1982 DATA TO PRIOR YEARS
FIVE YEAR COMPARISON OF RESIN SALES & USE BY MAJOR MARKET*
(millions of pounds, dry weight basis)

Major Market	1978	1979	1980	1981	1982
Transportation	2,015	1,934	1,605	1,573	1,392
Packaging	9,044	10,334	10,003	10,465	10,497
Building/Construction	6,965	7,573	6,424	7,259	7,154
Electrical/Electronic	2,952	3,043	2,453	2,670	2,275
Furniture/Furnishings	1,686	1,894	1,646	1,670	1,556
Consumer & Institutional	3,592	3,753	3,553	3,670	3,269
Industrial/Machinery	380	517	391	393	241
Adhesives, Inks & Coatings	2,902	2,794	2,387	2,572	1,584
All Other	2,939	3,443	3,054	3,259	3,232
Exports	2,588	3,432	3,670	3,425	3,909
Total	35,063	38,717	35,186	36,956	35,109

*Note: All figures exclude polyurethane

SHARE OF MARKET

The data reported by the Major Markets Subcommittee enables one to determine the fastest growing plastics markets. The data show, for example, the increasing role of "packaging" as a consumer of plastics resins in 1982.

COMPARATIVE PERCENTAGE DISTRIBUTION BY MAJOR MARKET

Major Market	1978	1979	1980	1981	1982
Transportation	5.7%	5.0%	4.6%	4.3%	4.0%
Packaging	25.8	26.7	28.4	28.3	29.9
Building/Construction	19.8	19.6	18.3	19.6	20.4
Electrical/Electronic	8.4	7.9	7.0	7.2	6.5
Furniture/Furnishings	4.8	4.9	4.7	4.5	4.4
Consumer & Institutional	10.3	9.7	10.1	9.9	9.3
Industrial/Machinery	1.1	1.3	1.1	1.1	0.7
Adhesives, Inks & Coatings	8.3	7.2	6.8	7.0	4.5
All Other	8.4	8.9	8.6	8.8	9.2
Exports	7.4	8.8	10.4	9.3	11.1
Total	100.0%	100.0%	100.0%	100.0%	100.0%

SUMMARY

These Major Market data demonstrate the important relationship between the plastics industry and the general economy. The factors affecting each are common to both: consumer buying attitudes; balance of trade; value of the dollar (inflation); the energy situation; the role of Government regulations; and the desire to increase productivity.

Advances in technology through combinations of plastics, and the use of additives and reinforcements have made plastics important basic raw materials. Plastics consumption continues to grow with consumer acceptance of plastics products not only as replacements for other materials but also where new markets are created through plastics' unique properties and versatility. The concept of plastics as basic materials has opened a new era for the industry.

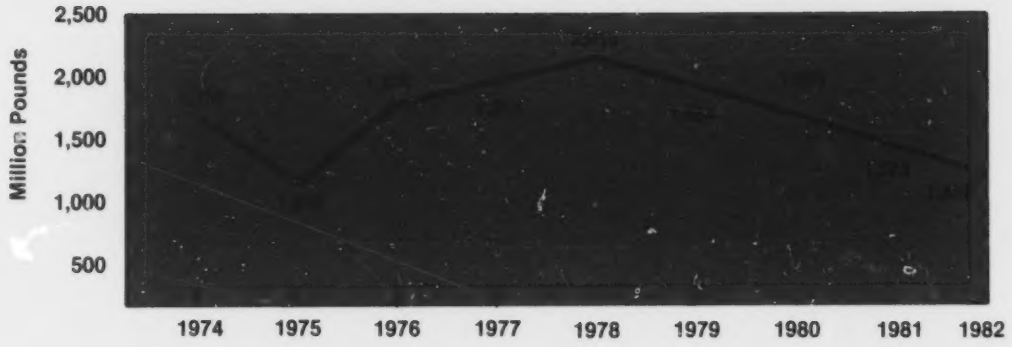
PERCENTAGE CHANGE IN SALES AND USE BY MAJOR MARKET

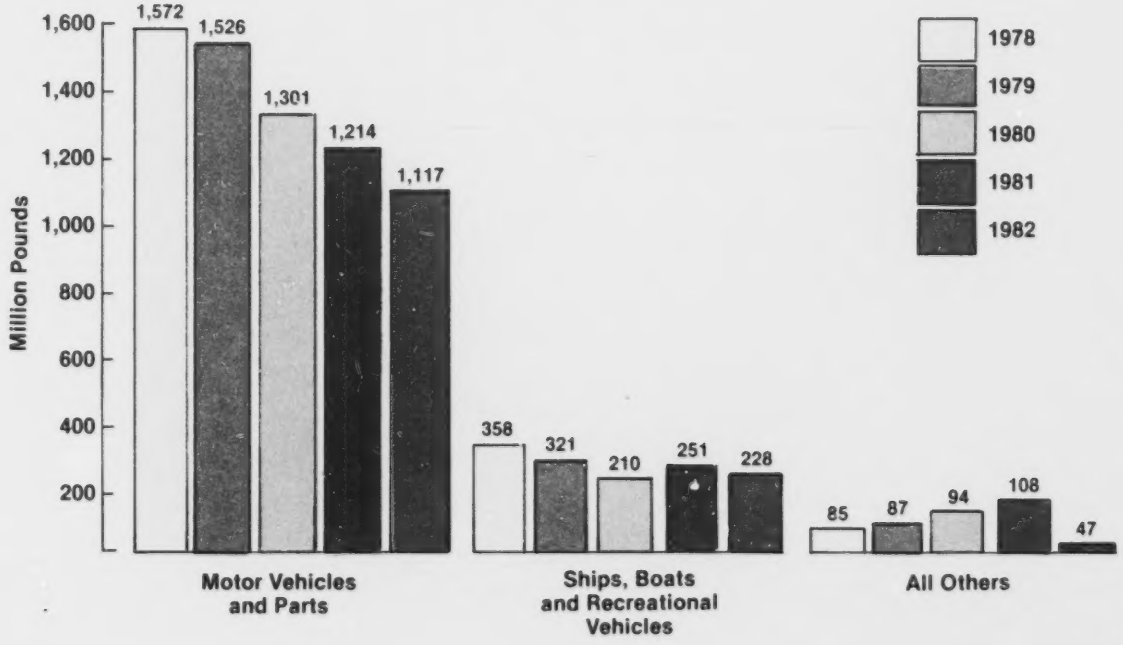
Major Market	% Change 1982/1981	% Change 1981/1980	Growth Rate 1977-1982
Transportation	−11.5%	−2.0%	−6.1%
Packaging	0.3	4.6	5.9
Building/Construction	−1.4	13.0	3.6
Electrical/Electronic	−14.8	8.8	−3.8
Furniture/Furnishings	−6.8	1.5	2.3
Consumer/Institutional	−10.9	3.3	0.2
Industrial/Machinery	−38.7	0.5	−12.6
Adhesives/Inks/Coatings	−38.4	7.8	−9.2
All Other	−0.8	6.7	3.4
Exports	14.1	−6.7	12.8
Total	−5.0%	5.0%	2.4%

ANALYSIS BY MAJOR MARKET

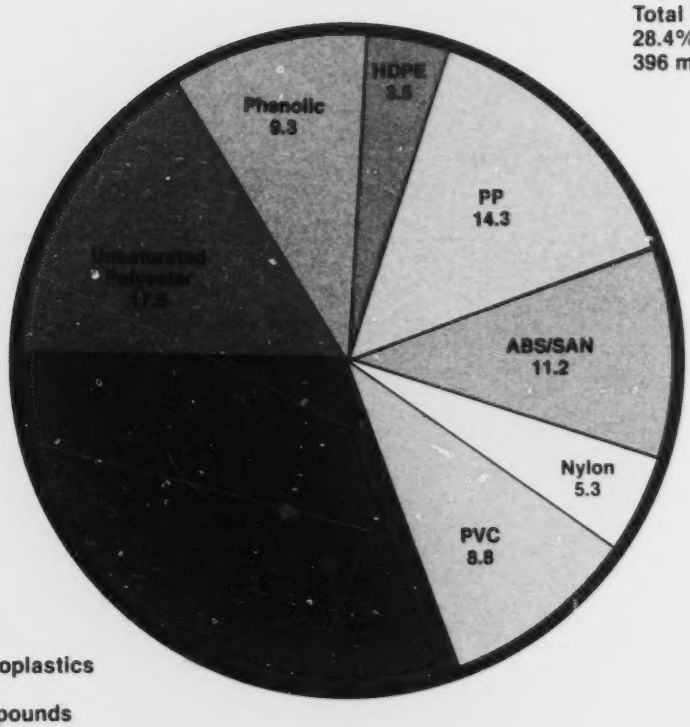
Note: Because of non-comparable "line-item" data, polyurethane foam is not included in the tables and graphs of this section. However, polyurethane foam consumption data by major market is provided in Appendix B.

TRANSPORTATION

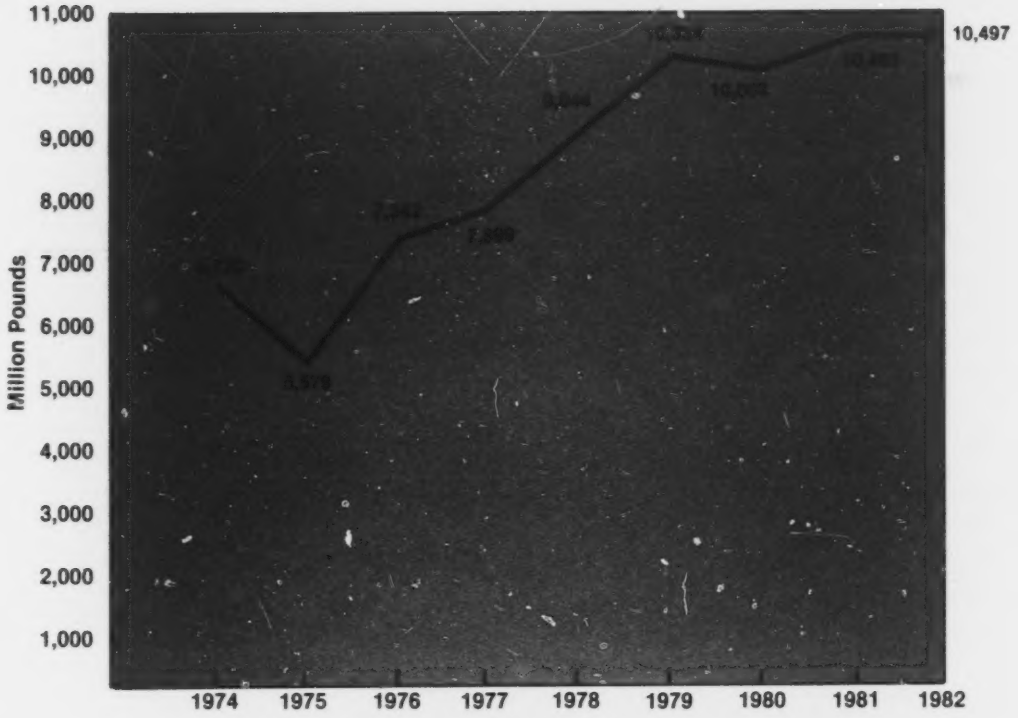


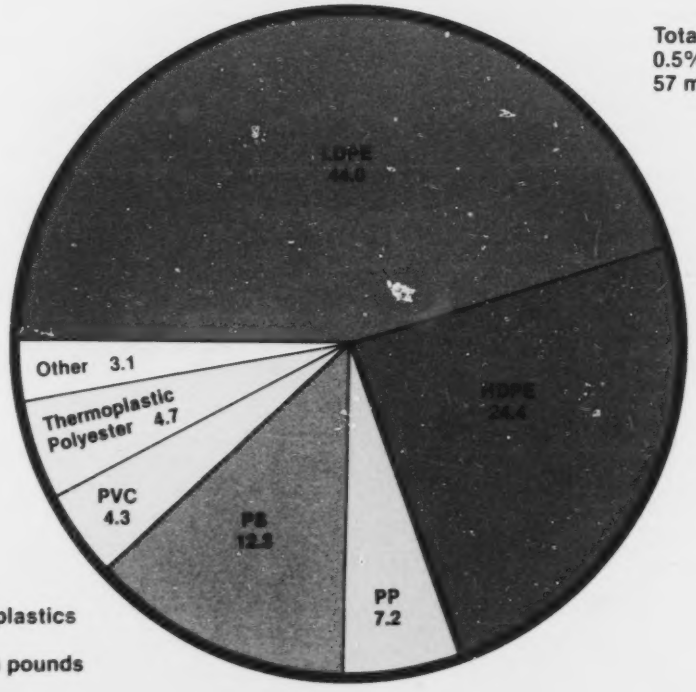


TRANSPORTATION (cont'd).



PACKAGING

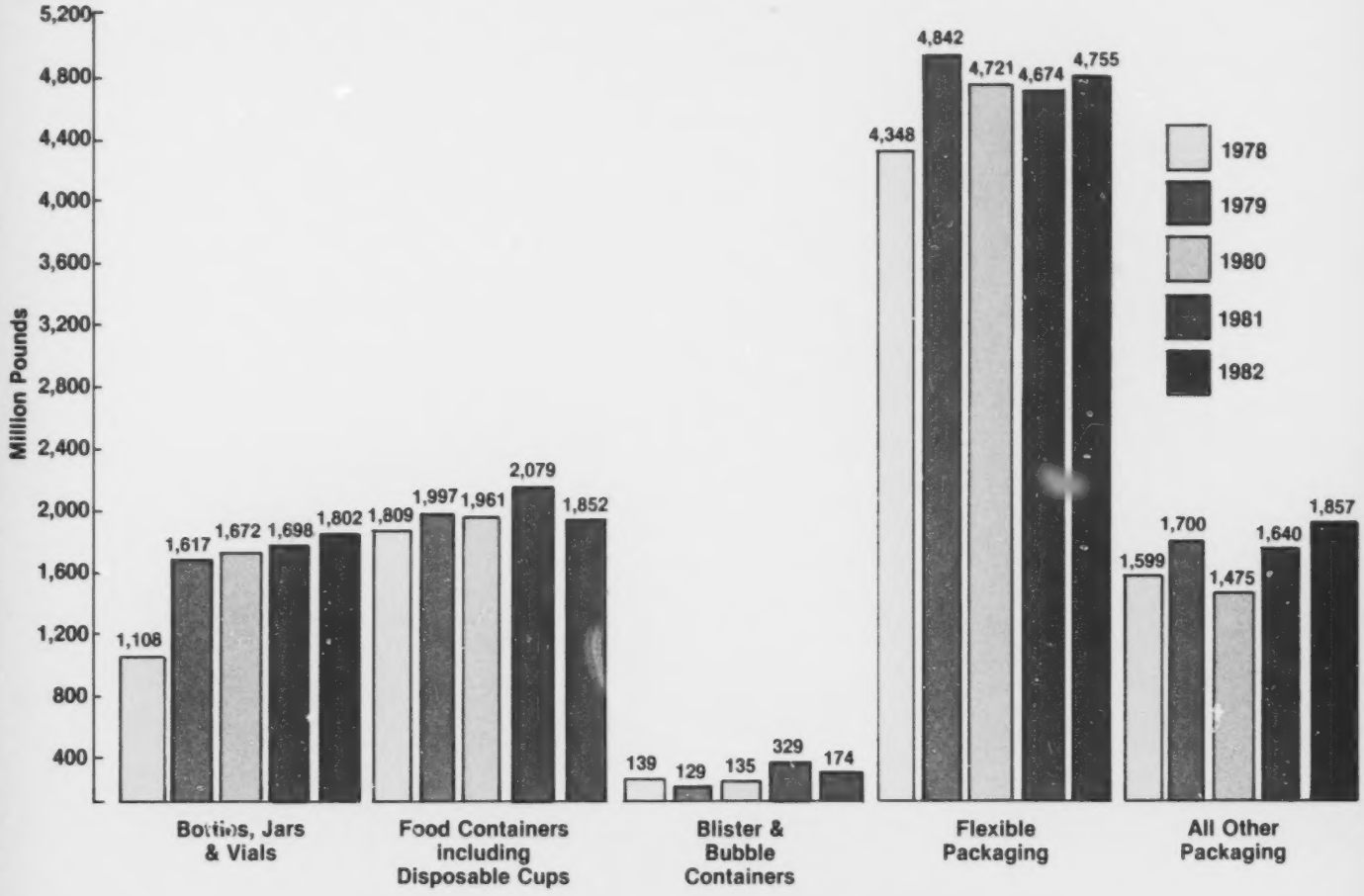




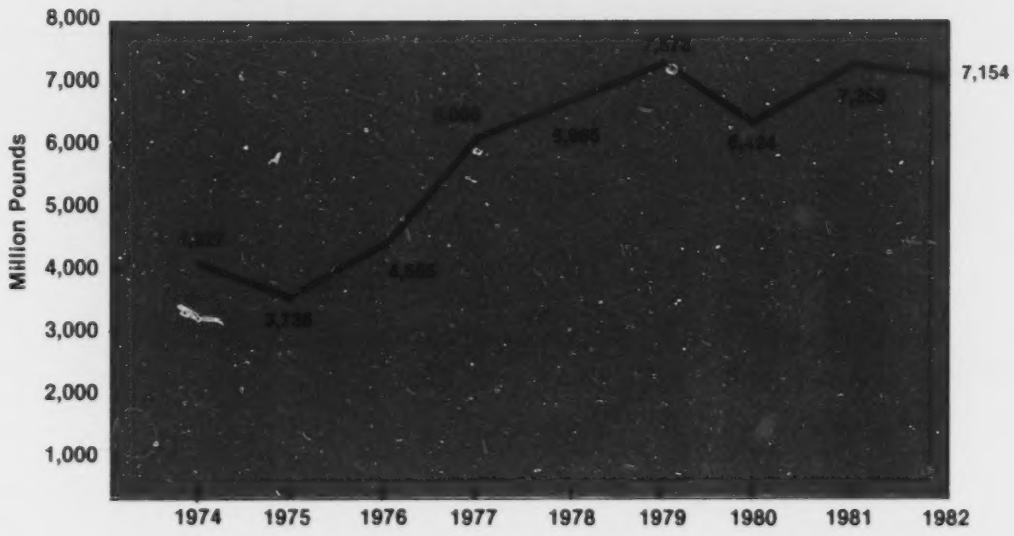
Total Thermosets
0.5%
57 million pounds

Total Thermoplastics
99.5%
10,440 million pounds

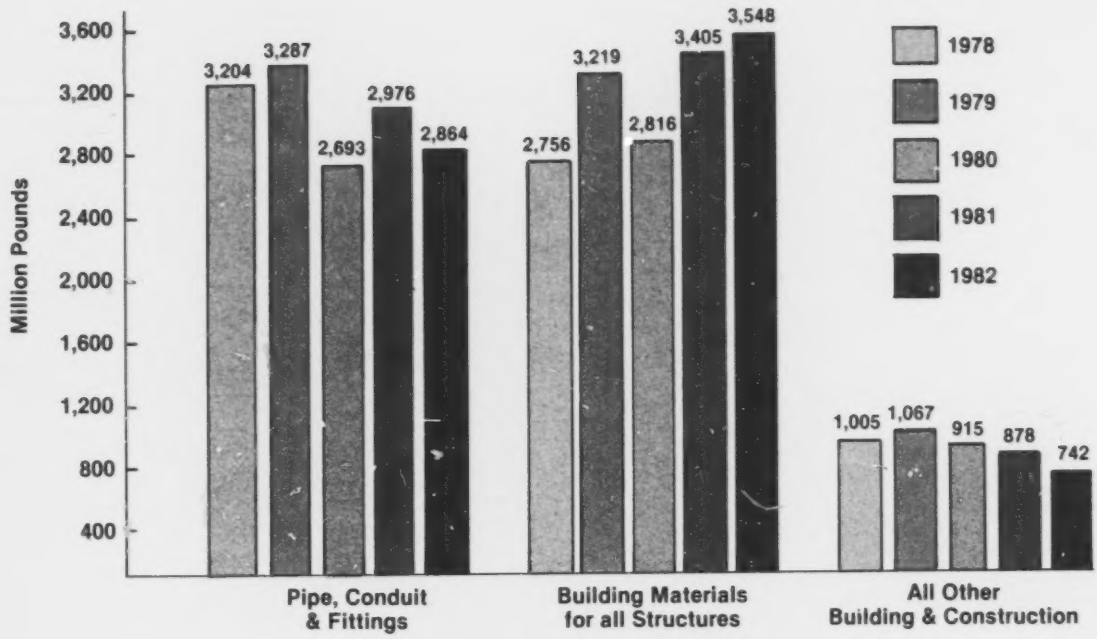
PACKAGING — THERMOPLASTIC DISTRIBUTION

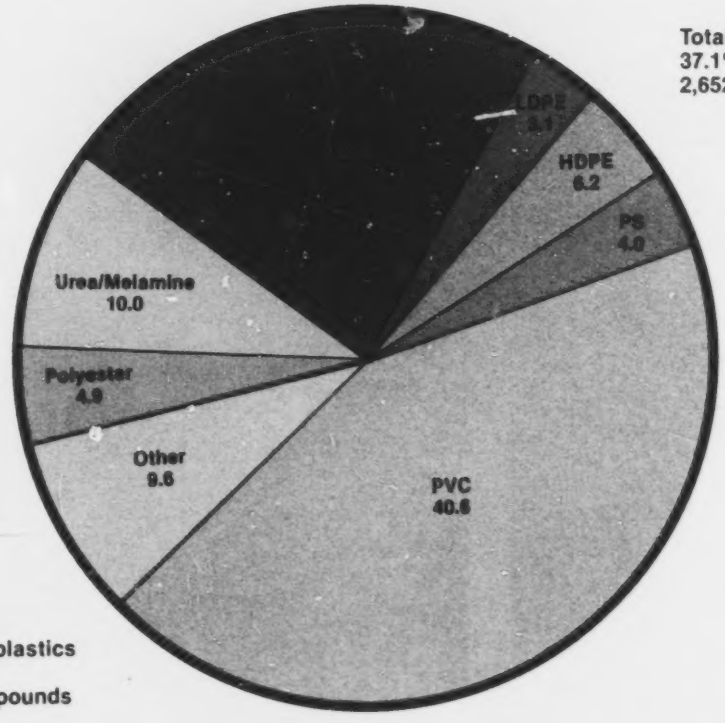


BUILDING AND CONSTRUCTION



BUILDING AND CONSTRUCTION (cont'd.)

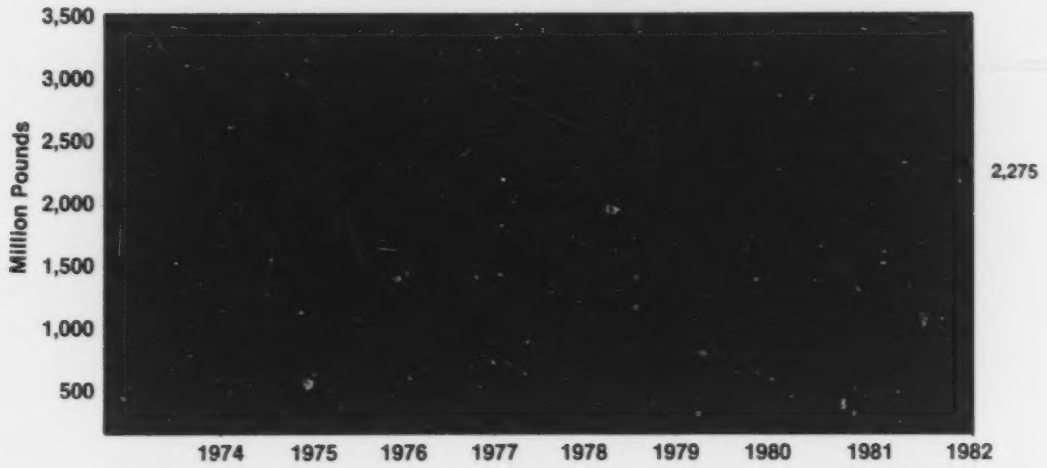


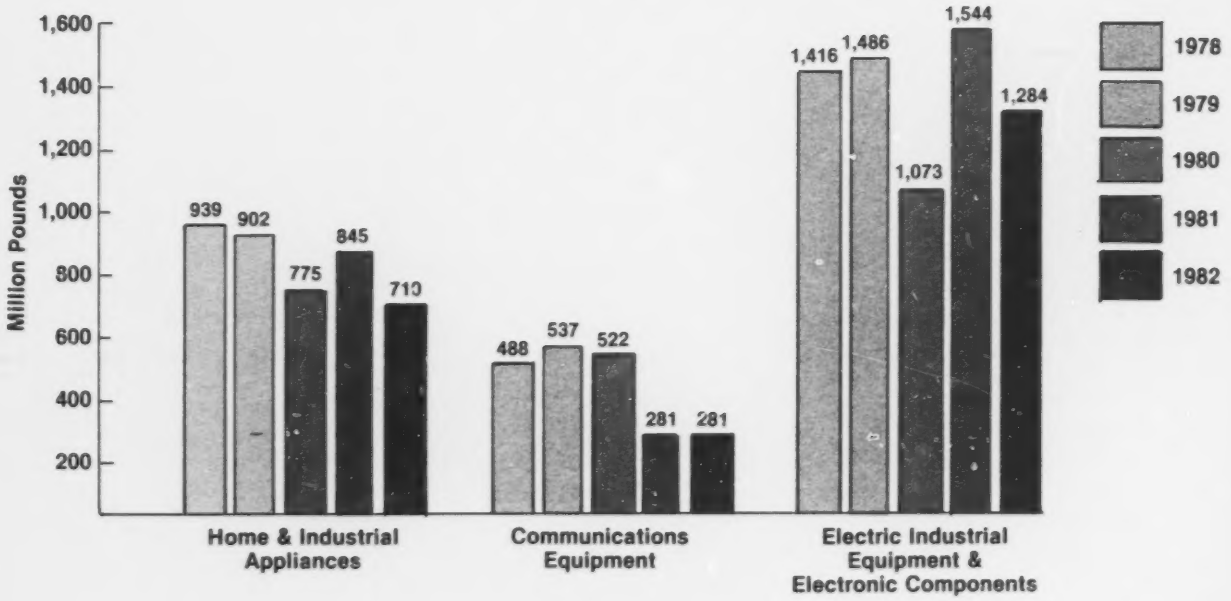


Total Thermosets
37.1%
2,652 million pounds

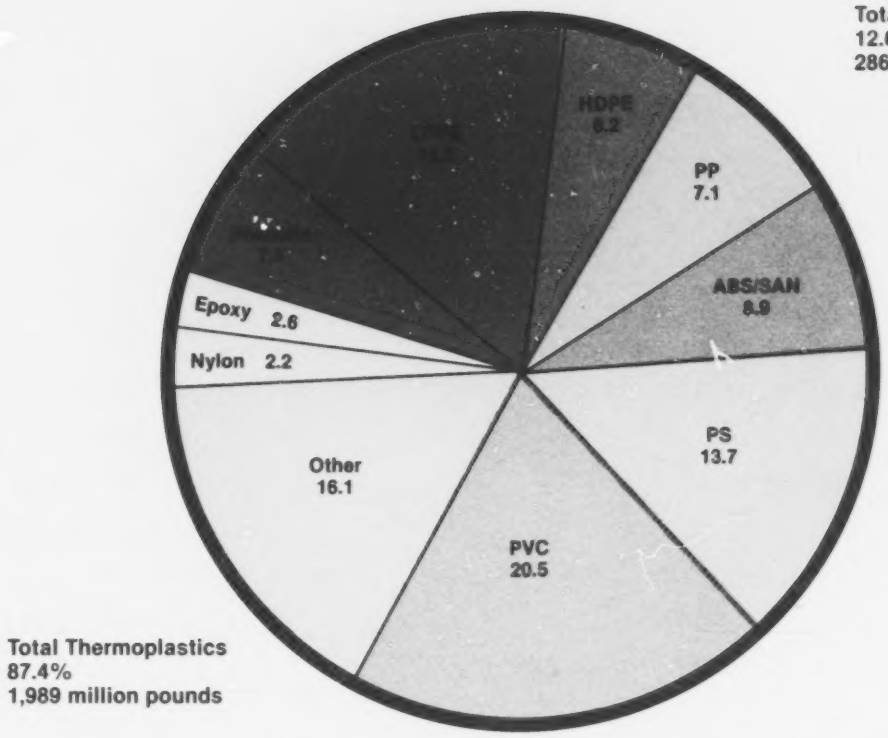
Total Thermoplastics
62.9%
4,502 million pounds

ELECTRICAL AND ELECTRONIC

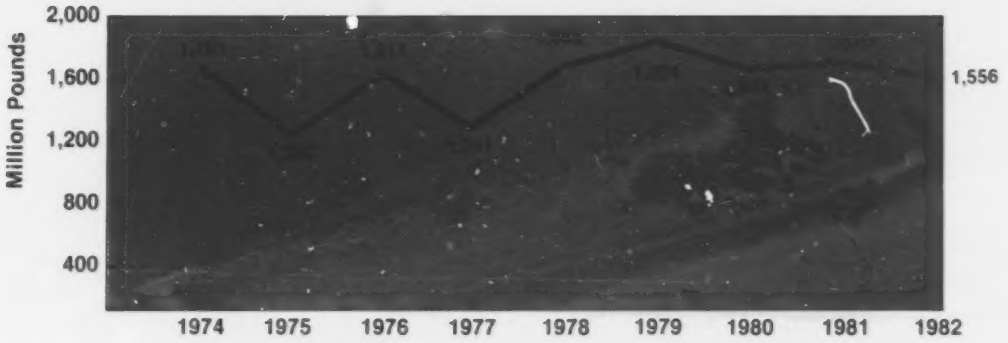


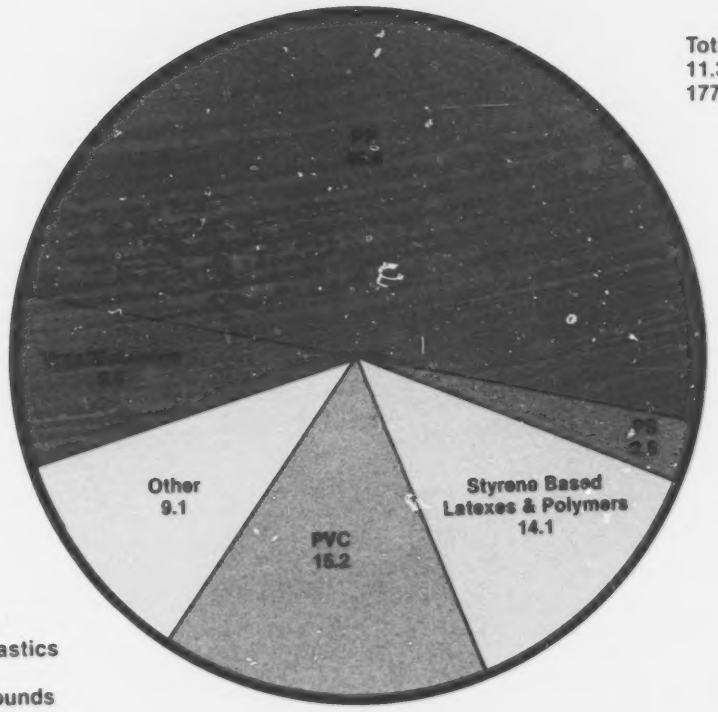


ELECTRICAL AND ELECTRONIC (cont'd.)



FURNITURE AND FURNISHINGS

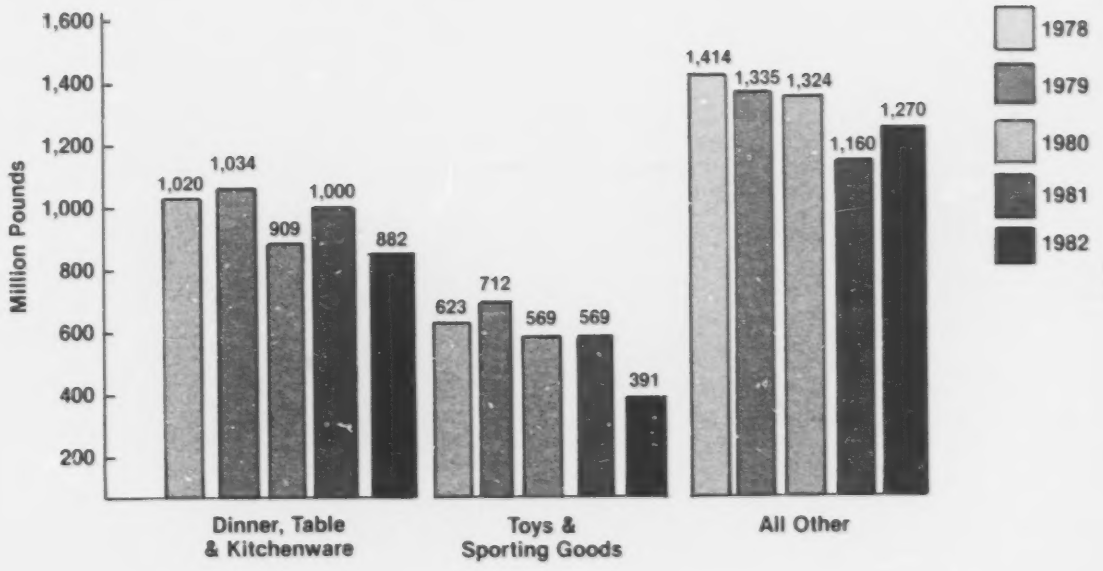




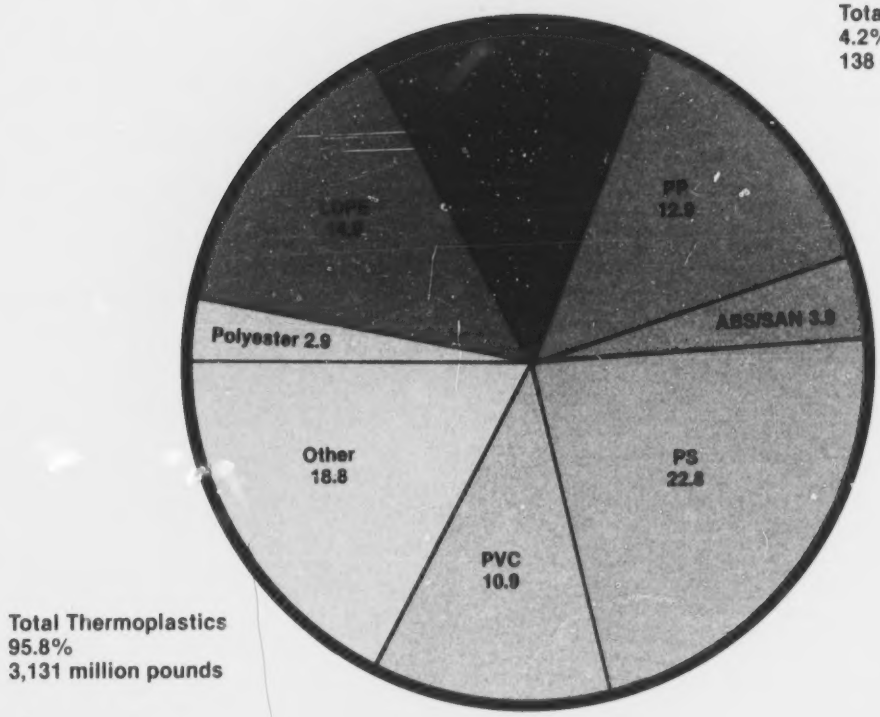
Total Thermosets
11.3%
177 million pounds

Total Thermoplastics
88.7%
1,380 million pounds

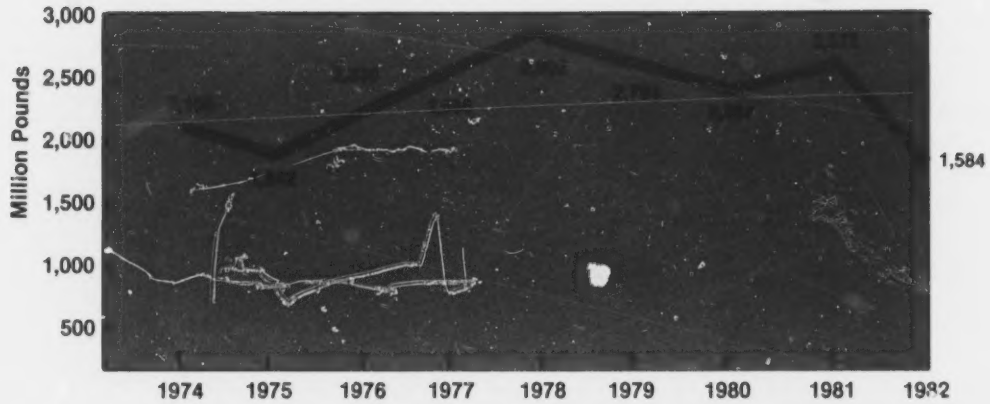
CONSUMER AND INSTITUTIONAL

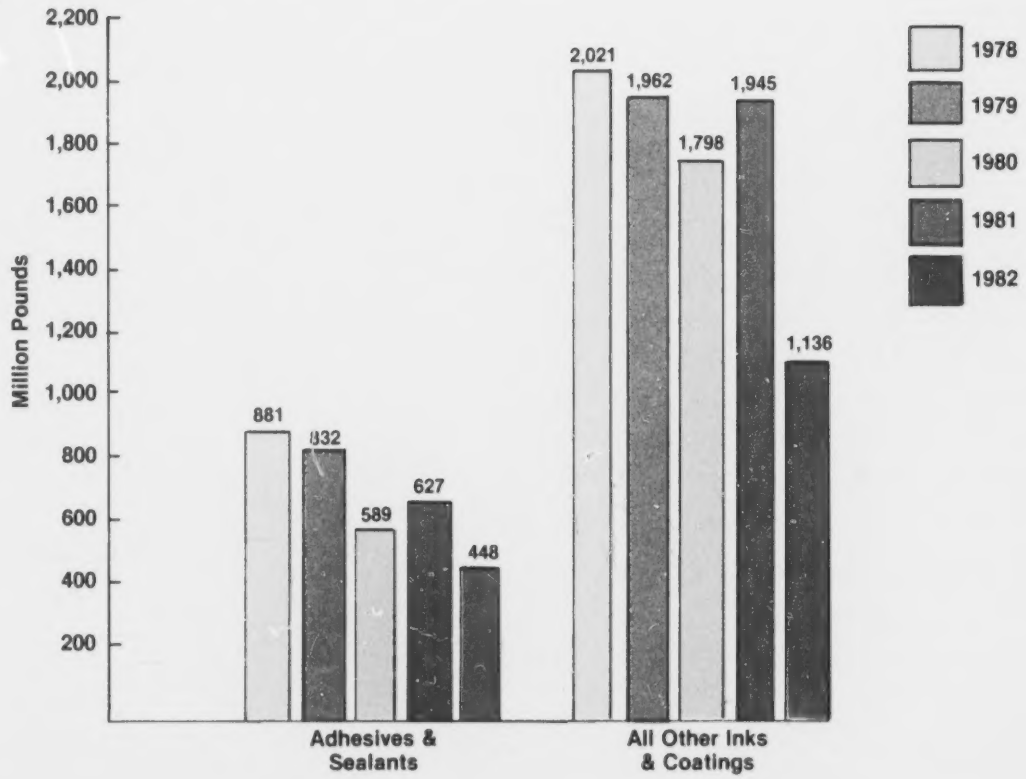


CONSUMER AND INSTITUTIONAL (cont'd.)

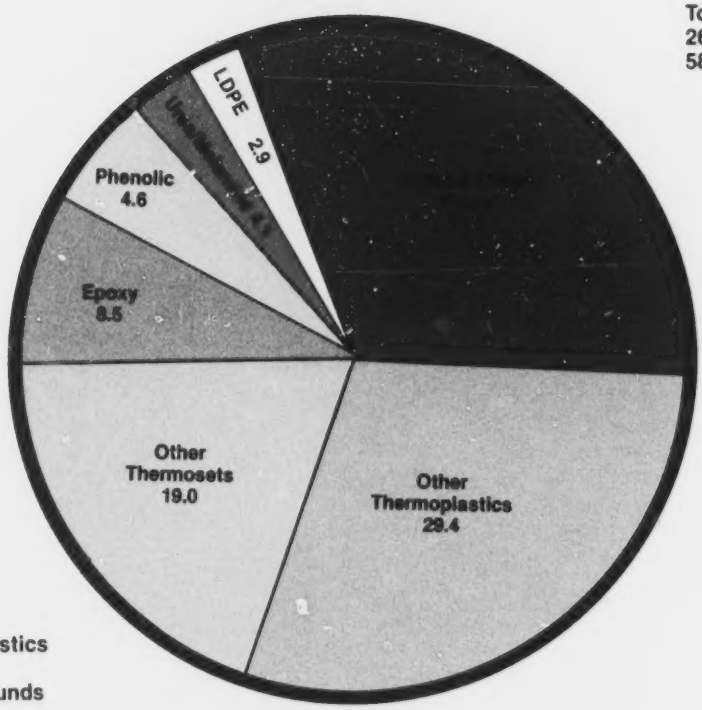


ADHESIVES/INKS/COATINGS





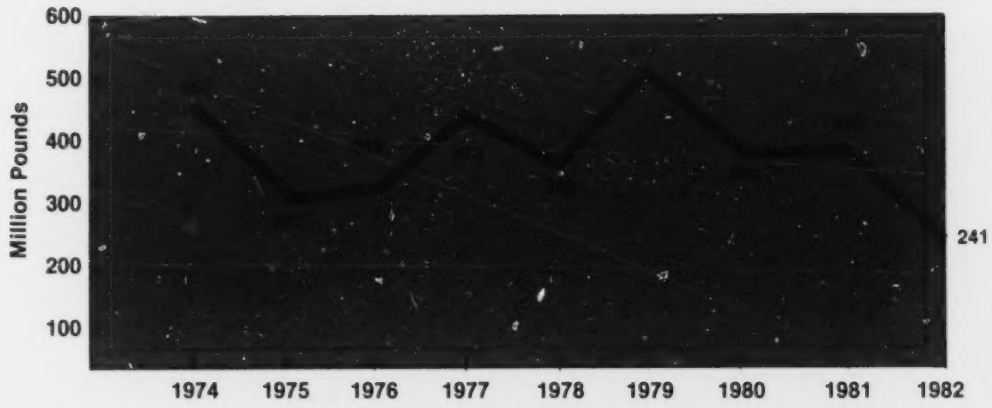
ADHESIVES/INKS/COATINGS (cont'd.)

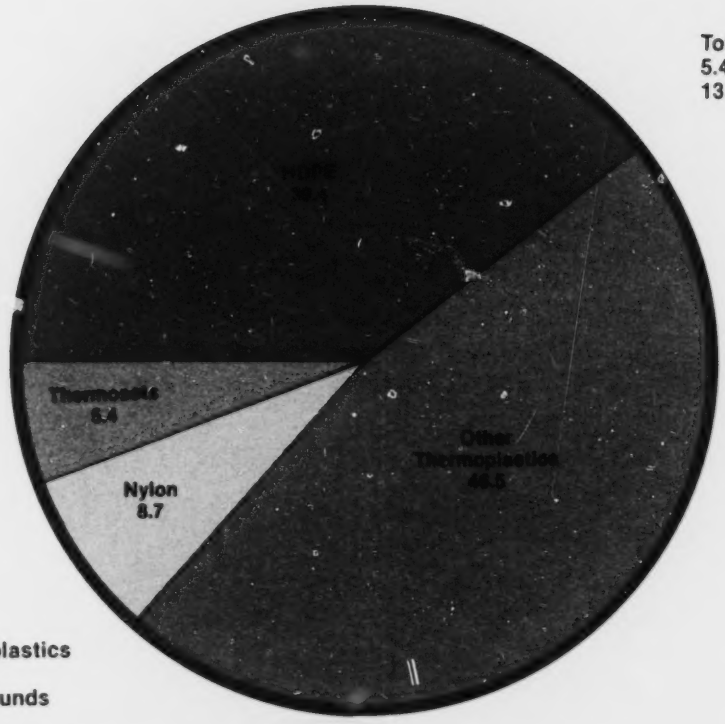


Total Thermosets
26.6%
580 million pounds

Total Thermoplastics
63.4%
1,004 million pounds

INDUSTRIAL/MACHINERY



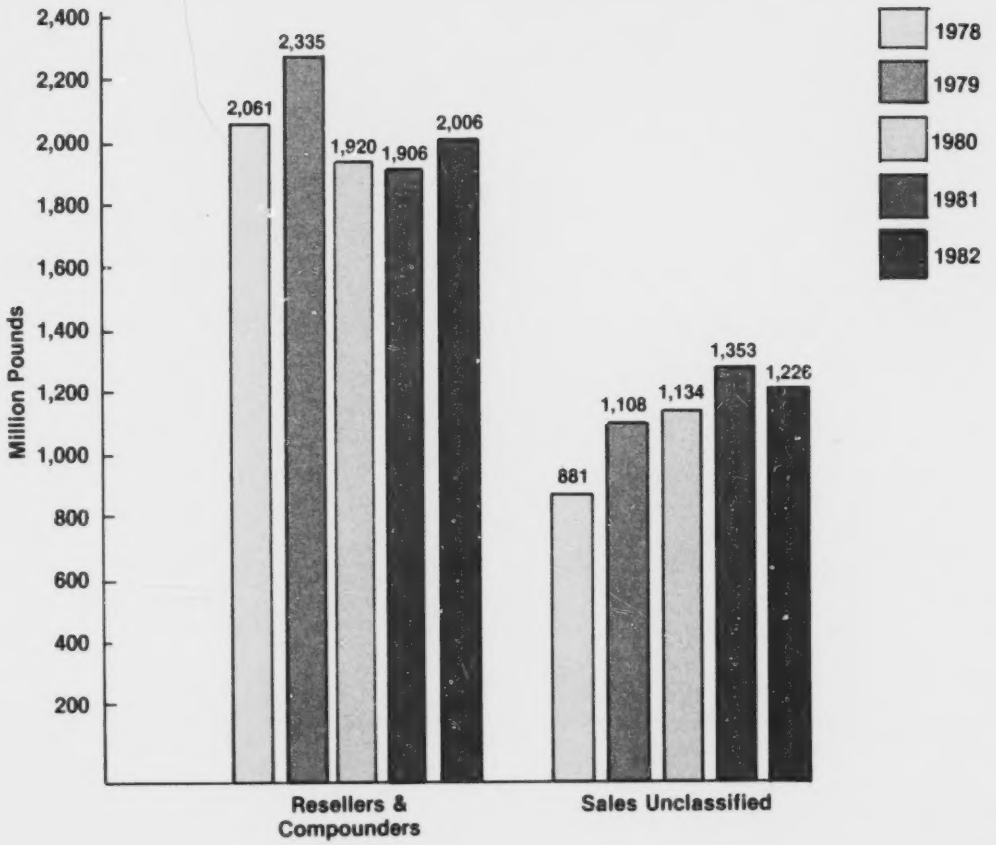


Total Thermosets
5.4%
13 million pounds

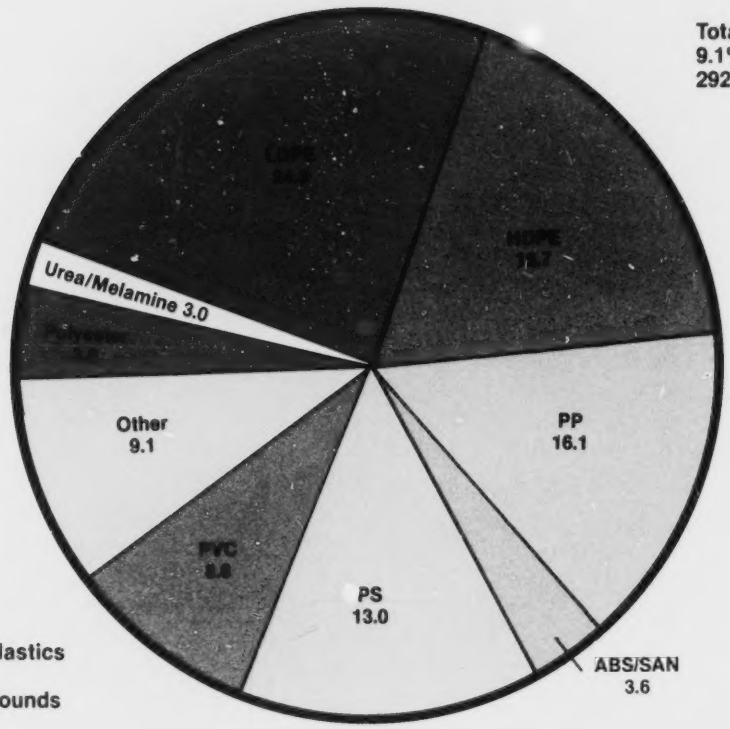
Total Thermoplastics
94.6%
228 million pounds

ALL OTHER

3,500
3,000
2,500
2,000
1,500
1,000
500
Million Pounds
3,232
1974
1975
1976
1977
1978
1979
1980
1981
1982


2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
Million Pounds
2,061
2,335
1,920
1,906
2,006
881
1,108
1,134
1,353
1,226
1978
1979
1980
1981
1982
Resellers & Compounders
Sales Unclassified

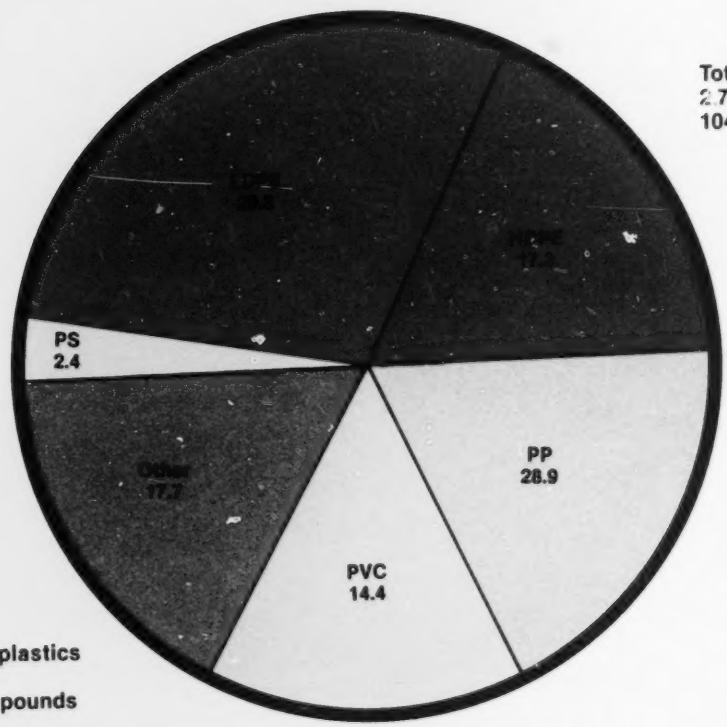
ALL OTHER (cont'd.)



Total Thermosets
9.1%
292 million pounds

Total Thermoplastics
90.9%
2,937 million pounds

EXPORTS



Total Thermosets
2.7%
104 million pounds

Total Thermoplastics
97.3%
3,805 million pounds

APPENDIX A

Table of 1982 distribution of plastics resins sales and use by Major Market, including market segments.

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1982 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis) (1)

MAJOR MARKET	TOTAL THERMOSETS		TOTAL THERMOPLASTICS		GRAND TOTAL (EXCLUDING POLYURETHANE FOAM)		POLYURETHANE FOAM	
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	396	8.4	996	3.3	1,392	4.0	260	15.5
Motor Vehicles and Parts	161	3.4	956	3.1	1,117	3.2		
Ships, Boats and Recreational Vehicles	204	4.3	24	0.1	228	0.7		
All Other Transportation Equipment	31	0.7	16	0.1	47	0.1		
PACKAGING, TOTAL	57	1.2	10,440	34.3	10,497	29.9	77	4.6
Bottles, Jars, Vials			1,802	5.9				
Food Containers Including Disposable Cups			1,852	6.1				
Blister and Bubble Containers			174	0.6				
Flexible Packaging - *(Bags, Liners, Etc.)*			4,755	15.6				
Household and Institutional Refuse Bags & Film			2,034	6.7				
All Other Flexible Packaging			2,721	8.9				
All Other Packaging	38	0.8	1,857	6.1	1,895	5.4		
BUILDING AND CONSTRUCTION, TOTAL	2,652	56.5	4,502	14.8	7,154	20.4	328	19.6
Pipe, Conduit and Fittings	87	1.8	2,777	9.1	2,864	8.2		
Building Materials for All Structures	2,087	44.5	1,461	4.8	3,548	10.1		
Siding	777	16.5	325	1.1	1,102	3.1		
Flooring	398	8.5	462	1.5	860	2.5		
Insulation Material	487	10.4	250	0.8	737	2.1		
All Other Building Materials for All Structures	425	9.1	424	1.4	849	2.4		
All Other Building and Construction	478	10.2	264	0.9	742	2.1		
ELECTRICAL/ELECTRONIC, TOTAL	286	6.1	1,989	6.5	2,275	6.5	80	4.8
Home and Industrial Appliances	100	2.1	610	2.0	710	2.0		
Communications Equipment	27	0.6	255	0.8	282	0.8		
Electric Industrial Equipment Combined with Electronic Components	159**	3.4**	1,124**	3.7**	1,283**	3.7**		
Storage Batteries								
FURNITURE AND FURNISHINGS, TOTAL	177	3.8	1,379	4.5	1,556	4.4	855	51.1
Rigid Furniture	171	3.6	107	0.4	278	0.8		
Flexible Furniture			11	0.0				
Carpet and Carpet Components			589	1.9				
Other Textiles and Furnishings			672	2.2				
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	138	2.9	3,131	10.3	3,269	9.3		
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.	38	0.8	844	2.8	882	2.5		
Health Care and Medical Products			441	1.4				
Toys and Sporting Goods	38	0.8	353	1.2	391	1.1		
Hobby and Graphic Arts Supplies			276	0.9				
All Other Consumer and Institutional Products	55	1.2	1,217	4.0	1,272	3.6		
INDUSTRIAL/MACHINERY, TOTAL	13	0.3	228	0.8	241	0.7		
ADHESIVES/INKS/COATINGS, TOTAL	580	12.4	1,004	3.3	1,584	4.5		
Adhesives and Sealants	82	1.8	366	1.2	448	1.3		
All Other Inks and Coatings	498	10.6	638	2.1	1,136	3.2		
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	292	6.2	2,937	9.7	3,229	9.2	74	4.4
Resellers and Compounders	67	1.4	1,939	6.4	2,006	5.7		
Sales Unclassified	225	4.8	998	3.3	1,223	3.5		
EXPORTS, TOTAL	104	2.2	3,808	12.5	3,912	11.1		
GRAND TOTAL	4,695	100.0	30,414	100.0	35,109	100.0	1,674	100.0

Page 1

** = Includes Storage Batteries

(1) = Except Phenolic Resins which are on a gross weight basis

SOURCE: SPI COMMITTEE ON RESINS STATISTICS AS COMPILED BY ERNST & WHINNEY

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1982 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis) (1)

MAJOR MARKET	EPOXY		POLYESTER		UREA & MELAMINE		PHENOLICS		ALL OTHER THERMOSETS	
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	D	D	244	28.7	D	D	129	6.3	D	D
Motor Vehicles and Parts			60	7.1			98	4.8		
Ships, Boats and Recreational Vehicles			173	20.3						
All Other Transportation Equipment			11	1.3						
PACKAGING, TOTAL	D	D	-	-	44	3.9	D	D	-	-
Bottles, Jars, Vials					-	-				
Food Containers Including Disposable Cups										
Blister and Bubble Containers					-	-				
Flexible Packaging - *(Bags, Liners, Etc.)*										
Household and Institutional Refuse Bags & Film					-	-				
All Other Flexible Packaging										
All Other Packaging										
BUILDING AND CONSTRUCTION, TOTAL	44	14.6	353	41.5	712	63.0	1,543	74.9	-	-
Pipe, Conduit and Fittings			63	7.4			9	0.4		
Building Materials for All Structures	12	3.9	103	12.1	514	45.4	1,458	70.8		
Siding	-	-					584	28.4		
Flooring							192	9.3		
Insulation Material	-	-					485	23.5		
All Other Building Materials for All Structures					143	12.6	197	9.6		
All Other Building and Construction			187	22.0			76	3.7		
ELECTRICAL/ELECTRONIC, TOTAL	60	19.9	26	3.0	D	D	170	8.2	D	D
Home and Industrial Appliances							86	4.2		
Communications Equipment							15	0.7		
Electric Industrial Equipment Combined with Electronic Components			18	2.1			69**	3.3**		
Storage Batteries			-	-						
FURNITURE AND FURNISHINGS, TOTAL	-	-	3	0.4	148	13.1	26	1.3	-	-
Rigid Furniture					142	12.6				
Flexible Furniture										
Carpet and Carpet Components			-	-						
Other Textiles and Furnishings										
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	-	-	95	11.2	D	D	D	D	-	-
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.			-	-						
Health Care and Medical Products										
Toys and Sporting Goods			38	4.5						
Hobby and Graphic Arts Supplies										
All Other Consumer and Institutional Products			48	5.6						
INDUSTRIAL/MACHINERY, TOTAL	D	D	-	-	-	-	D	D	-	-
ADHESIVES/INKS/COATINGS, TOTAL	134	44.5	7	0.8	65	5.7	73	3.5	301	85.8
Adhesives and Sealants	15	5.0					61	3.0	-	-
All Other Inks and Coatings	119	39.5					12	0.5	301	85.8
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	D	D	115	13.5	97	8.6	60	2.9	D	D
Resellers and Compounders			32	3.8			3	0.1		
Sales Unclassified			83	9.7			57	2.8		
EXPORTS, TOTAL	39	13.0	8	0.9	17	1.5	15	0.7	25	7.1
GRAND TOTAL	301	100.0	851	100.0	1,131	100.0	2,060	100.0	351	100.0

Page 2 Note: Table does not add vertically or horizontally due to disclosure.

SOURCE: SPI COMMITTEE ON RESINS STATISTICS AS COMPILED BY ERNST & WHINNEY

** = Includes Storage Batteries D = Disclosure

(1) = Except Phenolic Resins which are on a gross weight basis.

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1982 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis)

MAJOR MARKET	LOW DENSITY POLYETHYLENE		HIGH DENSITY POLYETHYLENE		POLYPROPYLENE		ABS & SAN		POLYSTYRENE		SBL, OSBL & OSBP	
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	D	D	49	1.0	199	5.5	156	19.0	4	0.1	D	D
Motor Vehicles and Parts			44	0.9			149	18.1				
Ships, Boats and Recreational Vehicles												
All Other Transportation Equipment												
PACKAGING, TOTAL	4,623	60.1	2,565	51.0	757	20.9	D	D	1,288	40.3	D	D
Bottles, Jars, Vials	24	0.3	1,015	20.2	105	2.9			75	2.3		
Food Containers Including Disposable Cups	284	3.7	669	13.3	41	1.1			815	25.5		
Blister and Bubble Containers					-	-			-	-		
Flexible Packaging - *(Bags, Liners, Etc.)*	3,624	47.1	400	8.0	314	8.7			88	2.8		
Household and Institutional Refuse Bags & Film	1,682	21.9	108	2.1					-	-		
All Other Flexible Packaging	1,942	25.2	292	5.8					88	2.8		
All Other Packaging					297	8.2			310	9.7		
BUILDING AND CONSTRUCTION, TOTAL	225	2.9	441	8.8	31	0.8	124	15.1	289	9.0	D	D
Pipe, Conduit and Fittings					20	0.6			6	0.2		
Building Materials for All Structures	131	1.7							258	8.0		
Siding					-	-	-	-	-	-		
Flooring	-	-	-	-	-	-	-	-	-	-		
Insulation Material			-	-			-	-	234	7.3		
All Other Building Materials for All Structures									23	0.7		
All Other Building and Construction									26	0.8		
ELECTRICAL/ELECTRONIC, TOTAL	345	4.5	142	2.8	161	4.4	203	24.7	311	9.7	D	D
Home and Industrial Appliances			9	0.2	77	2.1			238	7.4		
Communications Equipment			49	1.0								
Electric Industrial Equipment Combined with Electronic Components	294**	3.8**	84	1.6								
Storage Batteries			-	-								
FURNITURE AND FURNISHINGS, TOTAL	D	D	D	D	772	21.3	D	D	39	1.2	219	34.4
Rigid Furniture									26	0.8	-	-
Flexible Furniture											-	-
Carpet and Carpet Components					404	11.2			-	-		
Other Textiles and Furnishings					352	9.7						
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	487	6.3	421	8.4	421	11.6	129	15.7	745	23.3	D	D
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.	181	2.4	183	3.6	147	4.0	37	4.5	291	9.1		
Health Care and Medical Products	118	1.5	26	0.5	104	2.9			89	2.8		
Toys and Sporting Goods	24	0.3	73	1.4	34	0.9	24	2.9	156	4.9		
Hobby and Graphic Arts Supplies	-	-			10	0.3			53	1.6		
All Other Consumer and Institutional Products	164	2.1			126	3.5			156	4.9		
INDUSTRIAL/MACHINERY, TOTAL	D	D	95	1.9	D	D	D	D	D	D	D	D
ADHESIVES/INKS/COATINGS, TOTAL	46	0.6	D	D	D	D	-	-	D	D	D	D
Adhesives and Sealants												
All Other Inks and Coatings												
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	786	10.2	603	12.0	521	14.4	117	14.2	421	13.2	41	6.4
Resellers and Compounders	477	6.2	460	9.2	369	10.2	79	9.6	264	8.3		
Sales Unclassified	309	4.0	143	2.8	152	4.2	38	4.6	157	4.9		
EXPORTS, TOTAL	1,144	14.9	677	13.5	737	20.3	57	6.9	95	3.0	29	4.6
GRAND TOTAL	7,687	100.0	5,024	100.0	3,623	100.0	822	100.0	3,200	100.0	637	100.0

Page 3 Note: Table does not add vertically or horizontally due to disclosure.

SOURCE: SPI COMMITTEE ON RESINS STATISTICS AS COMPILED BY ERNST & WHINNEY

D = Disclosure

** = Includes Storage Batteries

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1982 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis)

MAJOR MARKET	NYLON		PVC		PVAc & OTHER VINYL RESINS		THERMOPLASTIC POLYESTER		ALL OTHER THERMOPLASTICS	
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	74	30.0	123	2.3	D	D	24	3.9	289	12.2
Motor Vehicles and Parts	61	24.7	114	2.1					289	12.2
Ships, Boats and Recreational Vehicles							-	-		
All Other Transportation Equipment										
PACKAGING, TOTAL	33	13.4	450	8.2	D	D	489	79.0	140	5.9
Bottles, Jars, Vials			109	2.0						
Food Containers Including Disposable Cups	-	-	18	0.3						
Blister and Bubble Containers	-	-	109	2.0					34	1.4
Flexible Packaging - (*Bags, Liners, Etc.*)			197	3.6					51	2.2
Household and Institutional Refuse Bags & Film	-	-					-	-		
All Other Flexible Packaging										
All Other Packaging			17	0.3					24	1.0
BUILDING AND CONSTRUCTION, TOTAL	D	D	2,902	53.2	15	2.0	D	D	473	20.0
Pipe, Conduit and Fittings			2,152	39.4	-	-			20	0.8
Building Materials for All Structures			631	11.6					414	17.5
Siding			264	4.8	-	-				
Flooring			281	5.2	-	-				
Insulation Material					-	-			-	-
All Other Building Materials for All Structures									222	9.4
All Other Building and Construction			119	2.2					39	1.6
ELECTRICAL/ELECTRONIC, TOTAL	50	20.2	467	8.6	D	D	D	D	275	11.6
Home and Industrial Appliances	8	3.2								
Communications Equipment	2	0.8								
Electric Industrial Equipment Combined with Electronic Components	40**	16.2**	315**	5.8**						
Storage Batteries										
FURNITURE AND FURNISHINGS, TOTAL	D	D	236	4.3	29	4.0	D	D	40	1.7
Rigid Furniture			4	0.1	-	-				
Flexible Furniture			8	0.1	-	-			-	-
Carpet and Carpet Components			32	0.6					-	-
Other Textiles and Furnishings			192	3.5						
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	13	5.3	356	6.5	D	D	8	1.3	521	22.0
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.			3	0.1					-	-
Health Care and Medical Products	4	1.6	40	0.7					34	1.4
Toys and Sporting Goods	2	0.8	17	0.3			-	-	21	0.9
Hobby and Graphic Arts Supplies			3	0.1			-	-	204	8.6
All Other Consumer and Institutional Products	6	2.4	293	5.3					262	11.1
INDUSTRIAL/MACHINERY, TOTAL	21	8.5	D	D	-	-	D	D	28	1.2
ADHESIVES/INKS/COATINGS, TOTAL	D	D	D	D	499	68.0	D	D	88	3.8
Adhesives and Sealants					234	31.9			44	1.9
All Other Inks and Coatings					265	36.1			44	1.9
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	29	11.7	278	5.1	15	2.0	9	1.5	117	4.9
Resellers and Compounders	23	9.3	150	2.7	4	0.5			92	3.9
Sales Unclassified	6	2.4	128	2.4	11	1.5			25	1.0
EXPORTS, TOTAL	18	7.3	566	10.4	43	5.9	48	7.8	395	16.7
GRAND TOTAL	247	100.0	5,455	100.0	734	100.0	619	100.0	2,366	100.0

Page 4 Note: Table does not add vertically or horizontally due to disclosure.

SOURCE: SPI COMMITTEE ON RESINS STATISTICS AS COMPILED BY ERNST & WHINNEY

** = Includes Storage Batteries
D = Disclosure

APPENDIX B

DISTRIBUTION OF POLYURETHANE FOAM SALES AND USE BY MAJOR MARKET

(in millions of pounds)

	Quantity					% of Total				
	1978	1979	1980	1981	1982	1978	1979	1980	1981	1982
Transportation	466	418	288	268	248	23.8%	21.7%	16.8%	15.4%	14.8%
Flexible	390	367	242	227	216	19.9	19.0	14.1	13.0	12.9
Rigid	76	51	46	41	32	3.9	2.7	2.7	2.4	1.9
Packaging	57	62	57	77	77	2.9	3.2	3.3	4.4	4.6
Flexible	33	31	23	35	34	1.7	1.6	1.3	2.0	2.0
Rigid	24	31	34	42	43	1.2	1.6	2.0	2.4	2.6
Furniture/Furnishings	980	973	872	898	859	50.0	50.4	50.9	51.5	51.3
Flexible	947	948	850	882	834	48.3	49.1	49.7	50.6	49.8
Rigid	33	25	22	16	21	1.7	1.3	1.2	0.9	1.5
Building/Construction	283	322	315	328	328	14.4	16.7	18.4	18.8	19.6
Electrical/Electronic	79	84	69	76	80	4.0	4.4	4.1	4.4	4.8
All Other	96	71	111	97	82	4.9	3.6	6.5	5.5	4.9
Total	1,961	1,930	1,712	1,744	1,674	100.0%	100.0%	100.0%	100.0%	100.0%

PROCESSING & MACHINERY

PROCESSING METHODS

INJECTION MOLDING

Injection molding is the principal method of forming thermoplastic materials. Modifications of the injection process are sometimes used for thermosetting plastics.

In injection molding, plastic material is put into a hopper which feeds into a heating chamber. A plunger pushes the plastic through this long heating chamber where the material is softened to a fluid state. At the end of this chamber there is a nozzle which abuts firmly against an opening into a cool, closed mold. The fluid plastic is forced at high pressure through this nozzle into the cold mold. As soon as the plastic cools to a solid state, the mold opens and the finished plastic is ejected from the press.

The problem with injection molding of thermosetting materials is that, under heat, these plastics will first soften, then harden to an infusible state. Thus it is essential that no softened thermosetting material in the heating chamber be allowed to remain there long enough to set.

Jet molding, offset molding and molding using a screw-type machine overcome this problem by liquefying the thermosetting plastic material just as it goes through the injection nozzle into the mold, but not before.

BLOW MOLDING

Blow molding is a method of forming used with thermoplastic materials.

Basically, blow molding consists of stretching and then hardening a plastic against a mold. There are two general methods of doing this type of thermoplastic molding: the direct method and the indirect method, encompassing several variations of each.

In the direct method, a glob of molten thermoplastic material is formed into the rough shape of the desired finished product. This shape is then inserted in a female mold and air blown into the plastic, as into a balloon, to force it against the sides of the mold. The formed material is then cooled before removal from the mold.

In the indirect method, a thermoplastic sheet or special shape is first heated, then clamped between a die and cover. Air pressure forced between the plastic and the cover forces the material into contact with the die, which has the contour desired in the finished product. The plastic is cooled before removal from contact with the die.

COMPRESSION MOLDING

Compression molding is the most common method of forming thermosetting materials. It is not generally used for thermoplastics.

Compression molding is simply the squeezing of a material into a desired shape by application of heat and pressure to the material in a mold.

Plastic molding powder, mixed with such materials or fillers as woodflour, cellulose and asbestos to strengthen or give other added qualities to the finished product, is put directly into the open mold cavity. The mold is then closed, pressing down on the plastic and causing it to flow throughout the mold. It is while the heated mold is closed that the thermosetting material undergoes a chemical change which permanently hardens it into the shape of the mold. The three compression molding factors—pressure, temperature and time mold is closed—vary with the design of the finished article and the material being molded.

EXTRUSION

Extrusion molding is the method employed to form thermoplastic materials into continuous sheeting, film, tubes, rods, profile shapes, filaments, and to coat wire, cable and cord.

In extrusion, dry plastic material is first loaded into a hopper, then fed into a long heating chamber through which it is moved by the action of a continuously revolving screw. At the end of the heating chamber the molten plastic is forced out through a small opening or die with the shape

desired in the finished product. As the plastic extrusion comes from the die, it is fed onto a conveyor belt where it is cooled, most frequently by blowers or by immersion in water.

In the case of wire and cable coating, the thermoplastic is extruded around a continuing length of wire or cable which, like the plastic, passes through the extruder die. The coated wire is wound on drums after cooling.

In producing wide film or sheeting, the plastic is extruded in the form of a tube. This tube may be split as it comes from the die and then stretched and thinned to the dimensions desired in the finished film.

In a different process, the extruded tubing is inflated as it comes from the die, the degree of inflation of the tubing regulating the thickness of the final film.

THERMOFORMING

Thermoforming of plastic sheet has developed rapidly in recent years. Basically, this process consists of heating thermoplastic sheet to a formable plastic state and then applying air and/or mechanical assists to shape it to the contours of a mold.

Air pressure may range from almost zero to several hundred psi. Up to approximately 14 psi (atmospheric pressure), the pressure is obtained by evacuating the space between the sheet and the mold in order to utilize this atmospheric pressure. This range, known as *vacuum forming*, will give satisfactory reproduction of the mold configuration in the majority of forming applications.

TRANSFER MOLDING

Transfer molding is most generally used for thermosetting plastics.

This method is like compression molding in that the plastic is cured into an infusible state in a mold under heat and pressure. It differs from compression molding in that the plastic is heated to a point of plasticity before it reaches the mold and is forced into a closed mold by means of an hydraulically-operated plunger.

Transfer molding was developed to facilitate the molding of intricate products with small deep holes or numerous metal inserts. The dry molding compound used in compression molding sometimes disturbs the position of the metal inserts and the pins which form the holes. The liquefied plastic material in transfer molding flows around these metal parts without causing them to shift position.

REACTION INJECTION MOLDING

Reaction injection molding (RIM) is a relatively new processing technique that has rapidly taken its place alongside more traditional methods. Unlike liquid casting, the two liquid components, polyols and isocyanates, are mixed in a chamber at relatively low temperatures (75°-140°F) before injection into a closed mold. An exothermic reaction occurs and consequently RIM requires far less energy usage than any other injection molding system.

The three major types of polyurethane RIM systems are rigid structural foam, low-modulus elastomers, and high-modulus elastomers.

Reinforced RIM (R-RIM) consists in the addition of such materials as chopped or milled glass fiber to the polyurethane to enhance stiffness and to increase modulus thus expanding the range of applications.

DOLLAR SALES OF PLASTICS MACHINERY[a]
(in millions of dollars)

Machine Type	1978	1979	1980	1981[r]	1982
Injection Molding	323.0	352.2	296.7	311.2	225.0
Structural Foam	9.5	10.6	11.7	8.7	5.0
Extrusion, single screw	102.0	195.7	203.5	201.0	140.0
Extrusion, multi screw	28.0	27.3	25.9	23.3	19.0
Blow Molding	81.0	91.0	100.0	100.0	89.0
Thermoforming	22.9	25.0	26.2	32.0	28.0
Reaction-Injection Molding	5.2	5.2	6.7	7.8	6.0
Compression	25.0	27.5	24.2	24.4	17.5
Foam Molding	3.5	15.0	14.8	15.5	13.5
Transfer Molding	7.3	7.8	8.1	8.0	6.0
Total	607.4	757.3	717.8	731.9	549.0

SHIPMENTS OF PLASTICS MACHINERY BY TYPE
(in number of units)

Year	Injection	Blow Molding	Transfer	Compression	Foam[b]	Thermo-forming[b]	Extruders (Single screw)	Extruders (Multi screw)	Structural Foam
1978	3,782	360	152	563	120	1,192	1,411	145	48
1979	3,690	425	154	586	207	525	1,500	136	51
1980	2,580	447	143	514	160	515	1,399	116	49
1981	2,385	406	131	466	125	582	1,069	97	34
1982	1,625	344	108	377	101	507	809	90	28

BLOW MOLDING			REACTION-INJECTION MOLDING/CLAMPS
Year	Domestic	Exports	Domestic & Exports
1978	327	33	72
1979	367	58	97
1980	359	88	155
1981	334	72	143
1982	290	54	120

[a]Includes value of machinery not shown in the tables below.

[b]Data base revised in 1979

r = Revised from 1982 edition.

Source: Domestic and export shipments of injection molding and extruders—The Society of the Plastics Industry supplemented by *Modern Plastics Annual Machinery Sales Survey.* All other figures *Modern Plastics.*

STRUCTURAL FOAM

Year	Domestic	Exports
1978	48	—
1979	47	4
1980	43	6
1981	31	3
1982	28	0

THERMOSET TRANSFER & INJECTION-TRANSFER MOLDING

Year	Domestic	Exports
1978	131	21
1979	140	14
1980	124	19
1981	107	24
1982	89	19

THERMOFORMING[c]

Domestic	Exports
1,053	139
464	61
434	81
512	70
451	56

FOAM MOLDING[c] (EXPANDED BEAD)

Year	Domestic	Exports
1978	106	14
1979	180	27
1980	131	29
1981	93	32
1982	76	25

COMPRESSION MOLDING

Domestic	Exports
538	25
553	23
487	27
441	25
350	27

[c]Data base revised in 1979
Source: *Modern Plastics*

INTERNATIONAL

PRODUCTION, IMPORTS, EXPORTS AND APPARENT CONSUMPTION OF PLASTIC MATERIALS—1980 and 1981 (000 Metric Tons)

Country	Production			Imports			Exports			Consumption		
	1980	1981	% change	1980	1981	% change	1980	1981	% change	1980	1981	% change
Australia	570	528	−7.4	130	135	+3.8	50	70	+40.0	699	717	+2.6
Austria	488	505	+3.5	354	365	+3.1	306	349	+14.1	536	521	−2.8
Belgium	—	—		—	—		—	—		489	512	+4.7
Canada	1355	1392	+2.7	344	373	+8.4	258	330	+27.9	1387	1435	+3.5
Chile	49	45	−8.2	60	59	−1.7	25	13	−48.0	84	91	+8.3
Denmark	0	0		344	340	−1.2	52	50	−3.8	292	289	−1.0
Fed. Rep. Germany	6738	6600	−2.0	2035	1962	−3.6	2700	2740	+1.5	6073	5822	−4.1
Finland	452	424	−6.2	239	242	+1.3	105	97	−7.6	586	569	−2.9
France	3152	3012	−4.4	1270	1235	−2.8	1613	1617	+0.2	2640	2498	−5.4
Italy	2710	2400	−11.4	1010	930	−7.9	900	845	−6.1	2820	2485	−11.9
Japan	7518	7038	−6.4	295	367	+24.4	1113	1166	+4.8	6700	6239	−6.9
Netherlands	1400	—		638	728	+14.1	2156	2276	+5.6	—	—	
Norway	260	274	+5.4	—	138		—	298		—	—	
South Africa	—	—		150	177	+18.0	30	21	−30.0	—	—	
Spain	1197	1110	−7.3	—	152		—	180		—	1082	
Sweden	520	473	−9.0	444	421	−5.2	250	251	+0.4	713	642	−10.0
Switzerland	128	122	−4.7	442	421	−4.8	126	130	+3.2	444	413	−7.0
United Kingdom	1813	1857	+2.4	711	823	+15.8	575	662	+15.1	1955	2018	+3.2
United States	16079	18084	+12.5	136	167	+22.8	1952	1672	−14.3	14263	16579	+16.2

Source: International Plastics Associations Directors' Status Report—1981

PLASTICS CONSUMPTION BY MARKET, 1981

Country	% of plastics consumption by market											
	1	2	3	4	5	6	7	8	9	10	11	12
Australia	23	25	7	5	8	3	1	6	2	*	*	20
Austria	21	31	10	4	11	4	1	3	2	7	4	2
Belgium	18	30	25	5	5	3	—	4	5	5	—	—
Canada	22	33.5	4.2	9.6	7.4	4.2	4.8	3.8	1.3	4.6	5.0	5.0
Chile	18	30	5	4	6	4	4	8	2	—	—	16
Denmark	15-20	25-30	50-60	50-60	50-60	50-60	50-60	50-60	50-60	50-60	50-60	50-60
Fed. Rep. Germany	25	21	15	7	5	4	—	2.5	—	—	10	10.5
France	18.4	35.1	7.6	7.5	3.7	4.8	—	5	—	2.6	—	15.8
Italy	10.5	31	9.5	5.7	5	4	7.5	5.5	0.7	1	14.6	5
Japan	13.1	23.7	13.1	7.5	1.1	3	1.3	8.4	0.3	1.6	14.4	12.5
Netherlands	11	47	4	1	—	—	1	12	1	2	—	21
South Africa	12	34	10	7	4	3	3	2	7	4	5	9
Spain	12	30	10	5	6	5	2	5	1	6	6	12
Sweden	18	26	13	5	4	1	—	3	—	16	—	—
Switzerland	26	21	12	4.5	4	5.5	*	5	*	7.5	—	14.5
United Kingdom	20	34	10	5	7	2	4	2.5	1	2	*	12.5
United States	19.6	28.3	7.2	4.3	4.5	—	—	9.9	—	1.1	7	18.1

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1. Building & Construction
2. Packaging
3. Electrical/Electronic
4. Transportation
5. Furniture
6. Agriculture
7. Toys & leisure items
8. Housewares
9. Clothing & footwear
10. Mechanical Enginnering
11. Glues, adhesives, paints, lacquers, inks
12. Other markets

*included in other markets

Source: International Plastics Associations Directors' Status Report—1981

PLASTICS MATERIALS INDUSTRY, 1981

Country	Turnover $m	No. of plants	No. of employees (000)
Australia	—	30	5.0
Austria	401	24	2.5
Belgium	—	25	5.0
Canada	1,918	64	6.2
Chile	48	11	1.5
Denmark	0	0	0
Fed. Rep. Germany	8,414	60	60.0
Finland	—	27	1.2
France*	3,982	—	19.4
Italy	3,090	60	20.0
Japan	9,541	144	38.4
Netherlands*	1,108	22	5.5
Norway	—	4	1.0
South Africa	—	25	7.0
Spain	1,337	98	8.1
Sweden	—	8	3.0
Switzerland	259	13	1.9
United Kingdom	2,600	200**	41.8
United States	17,000	400	54.0

*1980 figures.
**estimated—includes a number of small scale thermosetting material producers.
Source: International Plastics Associations Directors' Status Report—1981

THE PLASTICS PROCESSING INDUSTRY, 1981

Country	No. of Plants	No. of Employees	Value of Turnover $m	Sales per Employee $ th.
Austria	270	12,400	757	49.9
Belgium	600	30,000	—	—
Canada	1,800	55,000	3,920	71.3
Chile	360	14,000	310	22.0
Denmark	268	12,086	738†	61.0†
Fed. Rep. Germany	1,995*	201,200*	11,456	56.9
Finland	183	11,070	617	55.7
France	1,263	102,325**	8,304†	103.8†
Italy	2,900	96,000	5,004	52.1
Japan	22,900	328,750	24,455	74.5
Netherlands	537	19,271	1,503†	78.0†
Norway	600	13,000	—	—
South Africa	390	25,000	1,307	52.3
Spain	2,517	65,056	2,383	36.6
Sweden	760	35,000	2,964	79.1
Switzerland	1,151	17,490	1,039	59.4
United Kingdom	1,990‡	129,032‡	8,400	65.1
United States	25,000	470,000	37,000	78.7

*only 20 or more employees
**only 10 or more employees
†1980
‡Those establishments falling within the scope of the Plastics Processing Industry Training Board. The total figures are difficult to assess—there may be as many as 4,000 processors in all.
Source: International Plastics Associations Directors' Status Report—1981

SALES OF PLASTICS PRODUCTS, 1981

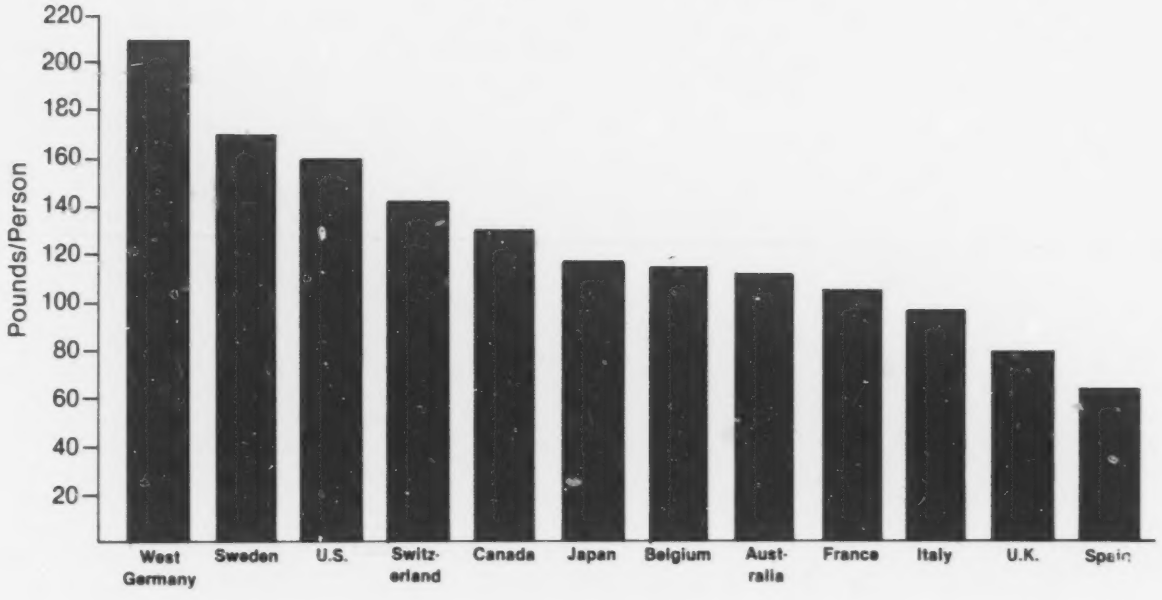
Country	Sales $ million		% change national	Sales per employee $ thousand		% change national currency
	1980	1981		1980	1981	
Australia	2,211	2,182	+3.3	—	—	—
Austria	681	757	+2.5	56.7	49.9	+0.6
Canada	3,613	3,920	+9.3	65.5	71.3	+3.3
Chile	350	310	−11.4	23.3	22.0	−5.6
Fed. Rep. Germany	13,291	11,456	−0.1	64.2	56.9	+2.8
Finland	811	617	−0.6	66.7	55.7	+0.2
France	8,304	—				
Italy	4,215	5,004	−6.6	41.7	52.1	−1.7
Japan	26,034	24,455	−3.9	83.7	74.5	−3.5
South Africa	912	1,307	+26.1	38.0	52.3	+21.1
Spain	2,650	2,383	+10.1	40.4	36.6	−9.0
Sweden	3,430	2,964	−13.1	85.8	79.1	+6.7
Switzerland	1,086	1,039	+7.0	62.6	59.4	+6.2
United Kingdom	10,855	8,400	−8.0	70.7	65.1	+9.8
United States	32,000	37,000	+15.6	69.6	78.7	+12.4

Source: International Plastics Associations Directors' Status Report—1981

U.S. PER CAPITA CONSUMPTION OF PLASTICS RESINS

Source: SPI, Bureau of the Census

PER CAPITA CONSUMPTION OF PLASTICS RESINS—1981 MAJOR CONSUMING COUNTRIES



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OTHER SOURCES OF PLASTICS INFORMATION

Business Consulting Groups and Publishers

Business Communications Co., Inc.—9 Viaduct Rd., Box 2070C, Stamford, Conn. 06906—203/325-2208
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Technomic Research Associates, Inc.—1 North Wacker Drive, Chicago, Ill. 60606—312/346-5900
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Census of Manufactures—Bureau of the Census
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Foreign Trade Reports: FT 135 (imports), FT 410 (exports)—Bureau of the Census
Guide to Census Bureau Data Files and Special Tabulations—Bureau of the Census
Guide to Foreign Trade Statistics—Bureau of the Census
Producer Price Indexes—Bureau of Labor Statistics
Standard Industrial Classification Manual—Office of Management and Budget
Statistical Abstract of the U.S.—Department of Commerce
Statistical Services of the U.S. Government—Office of Management and Budget
Synthetic Organic Chemicals—International Trade Commission
U.S. Industrial Outlook—Department of Commerce

Newspapers

Chemical Marketing Reporter—100 Church St., New York, N.Y. 10007—212/732-9820
Journal of Commerce—110 Wall St., New York, N.Y. 10005—212/425-1616
Rubber & Plastics News—1 Cascade Plaza, Suite 1302, Akron, Ohio 44308—216/253-2183

Trade Associations & Professional Organizations

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Packaging Digest—201 East 42nd St., New York, N.Y. 10017—212/867-9191
Plastics Compounding—1129 East 17th Ave., Denver, CO 80218—303/832-1022
Platics Design Forum—1129 East 17th Ave., Denver CO 80218—303/832-1022
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Plastics World—221 Columbus Ave., Boston, MA 02116—617/536-7780

MONTHLY STATISTICAL REPORT
on
THERMOSETTING & THERMOPLASTIC RESINS

This publication is the only source of monthly detailed data on production and sales & use (captive) available. A sample of the report follows on the next page. The following materials are included:

Epoxy	Polypropylene	Other Styrene-based Polymers
Polyester	ABS	Nylon
Urea	SAN	PVC
Melamine	Polystyrene	Polyvinyl Acetate
Phenolic	Styrene Butadiene Latexes	Polyvinyl Alcohol
LD Polyethylene	Other Styrene-based Latexes	Other Vinyl Resins
HD Polyethylene		Thermoplastic Polyester

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MONTHLY STATISTICAL REPORT
THE SOCIETY OF THE PLASTICS INDUSTRY, INC.
(In thousands of pounds, dry weight basis)

THERMOSETTING RESINS

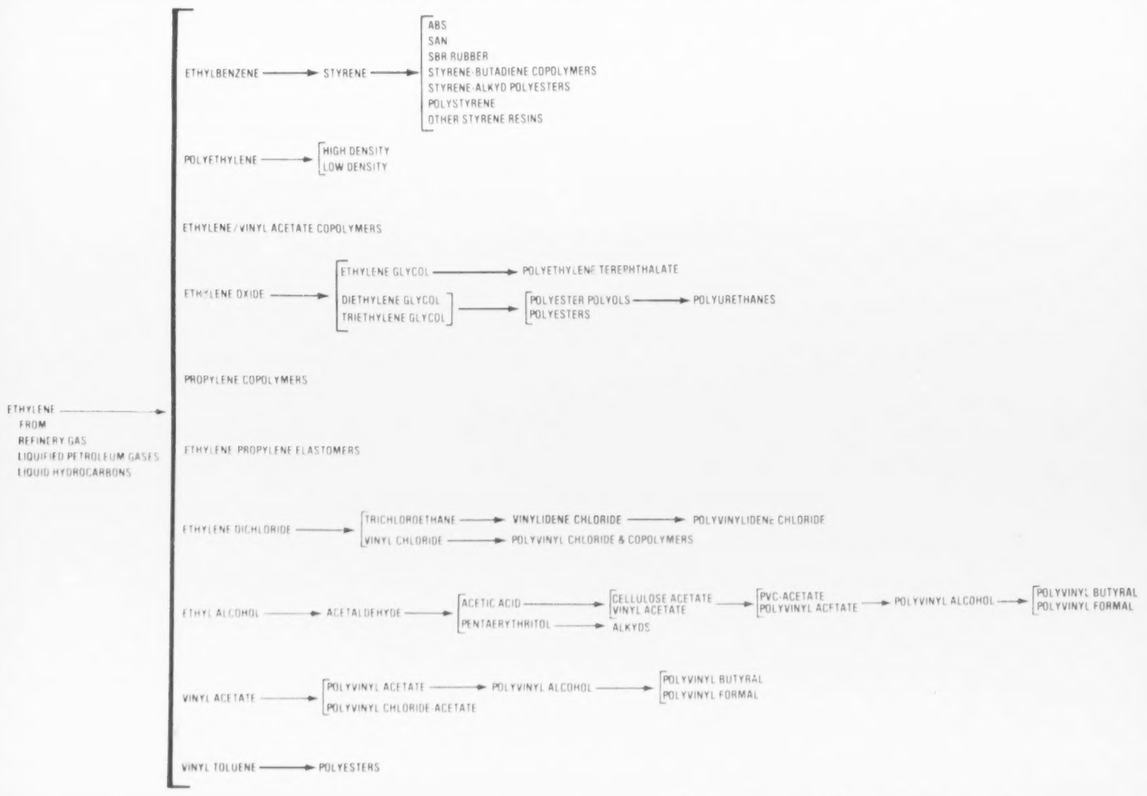
DECEMBER 1980

RESIN KIND & USE	SALES & CAPTIVE USE						PRODUCTION					
	DECEMBER			YEAR-TO-DATE			DECEMBER			YEAR-TO-DATE		
	1980	1979	% Change	1980	1979	% Change	1980	1979	% Change	1980	1979	% Change
EPOXY (UNMODIFIED) RESINS, TOTAL	30,709	25,639	+ 19.8	318,756R	331,970	– 4.0	26,491	24,829	+ 6.7	315,039R	361,077	– 12.8
Total Exports	3,732	3,496	+ 6.8	35,547	35,730	– 0.5						
Total Domestic	26,977	22,143	+ 12.8	283,209R	296,240	– 4.4						
Bonding & Adhesives	1,931	1,431	+ 34.9	17,742R	17,454	+ 1.7						
Flooring, Paving & Exposed Aggregate	1,886	1,481	+ 27.3	19,231R	19,583	– 1.8						
Protective Coatings	13,417	9,648	+ 39.1	137,306R	146,137	– 6.0						
Fiber Reinforced Laminates & Composites	5,164	4,785	+ 7.9	62,690R	60,266	+ 4.0						
Tooling, Casting & Molding Resins	2,749	2,417	+ 13.7	25,664R	30,940	– 17.1						
All Other Uses	1,830	2,381	– 23.1	20,574R	21,858	– 5.9						
POLYESTER (UNSATURATED) RESINS, TOTAL	75,749	76,020	– 0.4	921,169R	1,151,581	– 20.0	76,524	78,733	– 2.8	925,947R	1,147,174	– 19.3
General Purpose Resins							66,503	68,719	– 3.2	805,583R	1,010,750	– 20.3
Fire Retardant Resins							2,757	2,550	+ 8.1	28,739	32,035	– 10.3
Chemical Resistant Resins							7,264	7,464	– 2.7	91,625R	104,389	– 12.2
Isophthalic Resins							3,830	4,917	– 22.1	52,437R	63,156	– 17.0
All Other Resins							3,434	2,547	+ 34.8	39,188R	41,231	– 5.0
Total Exports	903	841	+ 7.4	11,254	14,250	– 21.0						
Total Domestic	74,846	75,179	– 0.4	909,915R	1,137,061	– 20.0						
Reinforced Plastics, Total	59,069	58,428	+ 1.1	700,229R	895,949	– 21.7						
Non-Reinforced Plastics, Total	15,777	16,751	– 5.8	209,686R	231,112	– 13.2						
LOW-DENSITY POLYETHYLENE 0.940 & BELOW, TOTAL	719,992	668,312	+ 8.1	7,467,465R	7,814,845	– 4.4	675,113	650,391	+ 3.8	7,290,727R	7,793,223	– 6.4
Total Exports	109,576	65,000	+ 68.6	1,147,442R	897,575	+ 27.8						
Total Domestic	610,416	65,000	+ 68.6	1,147,442R	897,575	+ 27.8						
Film (12 Mils & Below)	610,416	601,312	+ 1.5	6,320,023R	6,917,270	– 8.6						
Sheet (Over 12 Mils)	392,242	383,360	+ 2.3	4,003,749	4,363,250	– 8.2						
Injection Molding	921	1,930	– 52.3	18,176	25,825	– 29.6						
Wire & Cable	46,555	57,100	– 18.5	519,294R	649,975	– 20.1						
Extrusion Coating	20,042	34,572	– 42.0	335,403	424,139	– 20.9						
Blow Molding	44,772	41,001	+ 9.2	517,406R	539,096	– 4.0						
Pipe & Conduit	5,129	4,786	+ 7.2	65,453R	59,524	+ 10.0						
Other Extruded Products	2,660	2,293	+ 16.0	21,768R	32,716	– 33.5						
All Other Uses	4,244	5,140	– 17.4	56,018R	79,614	– 29.6						
HIGH-DENSITY POLYETHYLENE ABOVE 0.940, TOTAL	93,851	71,130	+ 31.9	782,756R	743,127	+ 5.3						
Total Exports	413,377	394,243	+ 4.9	4,393,038R	4,893,243	– 10.2	407,174	419,864	– 3.0	4,405,021	5,009,839	– 12.1
Total Domestic	61,114	54,188	+ 12.8	526,438R	608,654	– 13.5						
Film (12 Mils & Below)	352,263	340,055	+ 3.6	3,866,600	4,284,589	– 9.8						
Sheet (Over 12 Mils)	21,622	14,714	+ 46.9	201,086	212,399	– 5.3						
Injection Molding	7,921	4,541	+ 74.4	54,937	65,520	– 16.2						
Wire & Cable	89,601	84,541	+ 6.0	937,964	1,073,724	– 12.6						
Extrusion Coating	6,285	7,074	– 11.2	105,555	125,921	– 16.2						
Blow Molding	3,213	2,038	+ 57.7	27,565	30,242	– 8.9						
Pipe & Conduit	138,168	139,521	– 1.0	1,573,140	1,724,076	– 8.8						
Other Extruded Products	30,468	25,135	+ 21.2	368,352	400,395	– 8.0						
All Other Uses	1,703	2,120	– 19.7	24,250	18,931	+ 28.1						
	53,282	60,371	– 11.7	573,751	633,361	– 9.4						

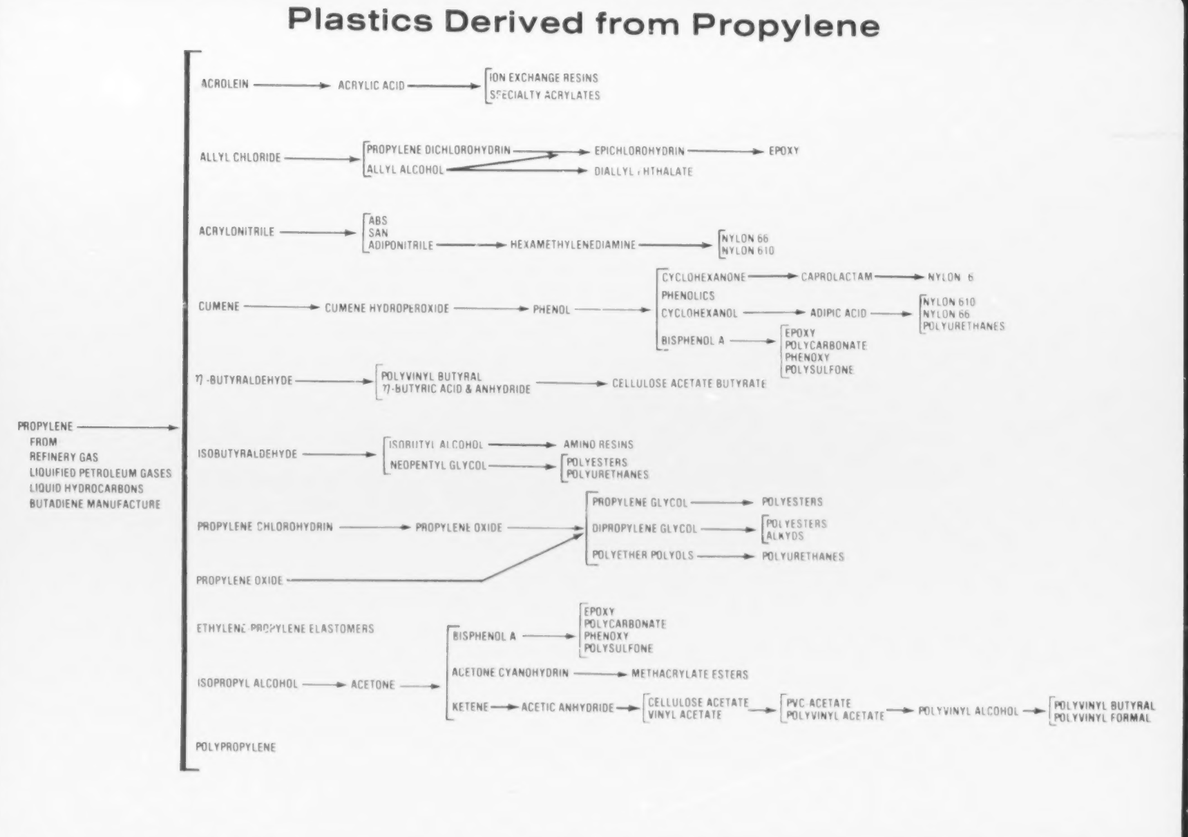
SAMPLE

Facts & Figures of the Plastics Industry

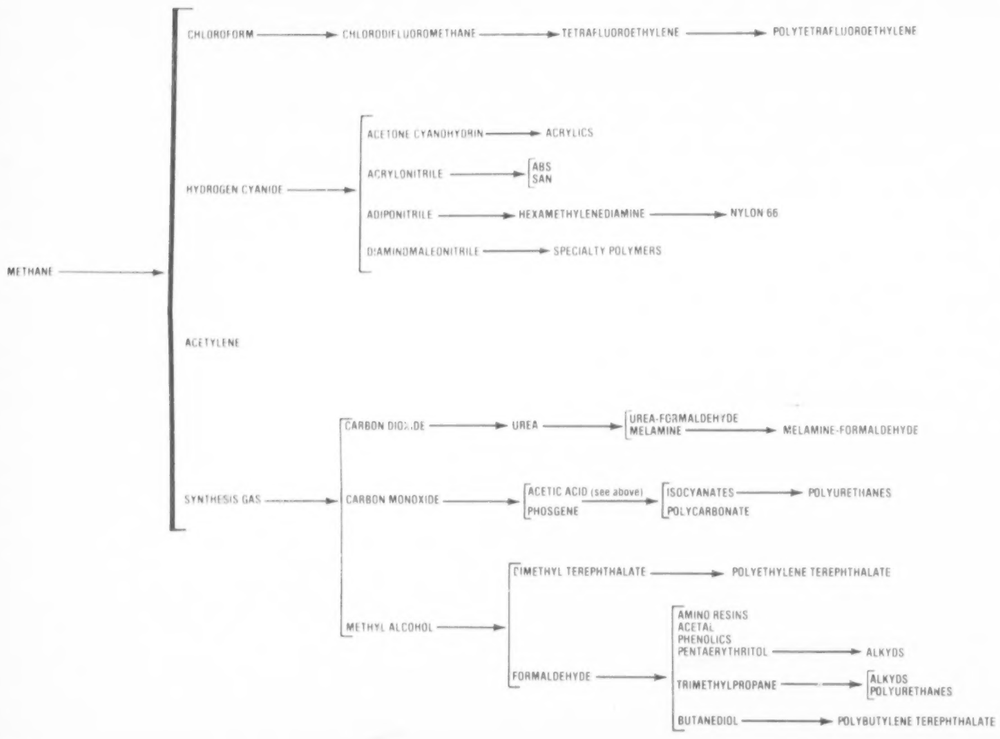
Plastics Derived from Ethylene



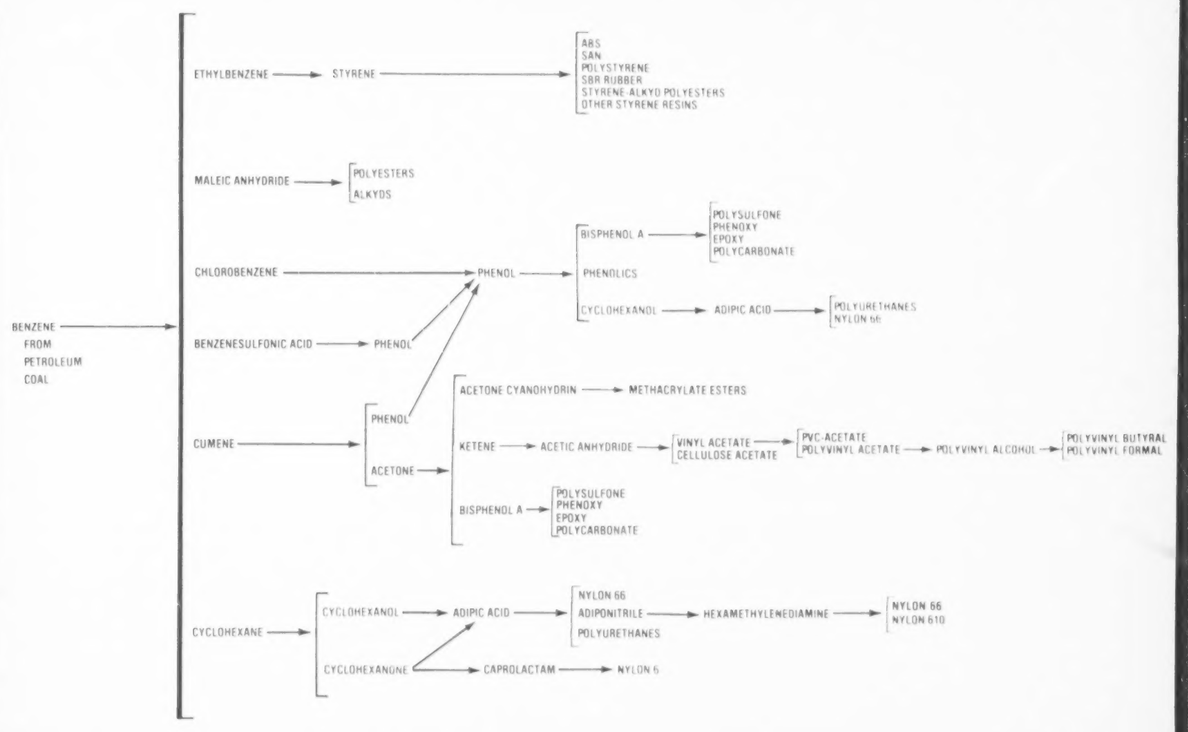
Plastics Derived from Propylene



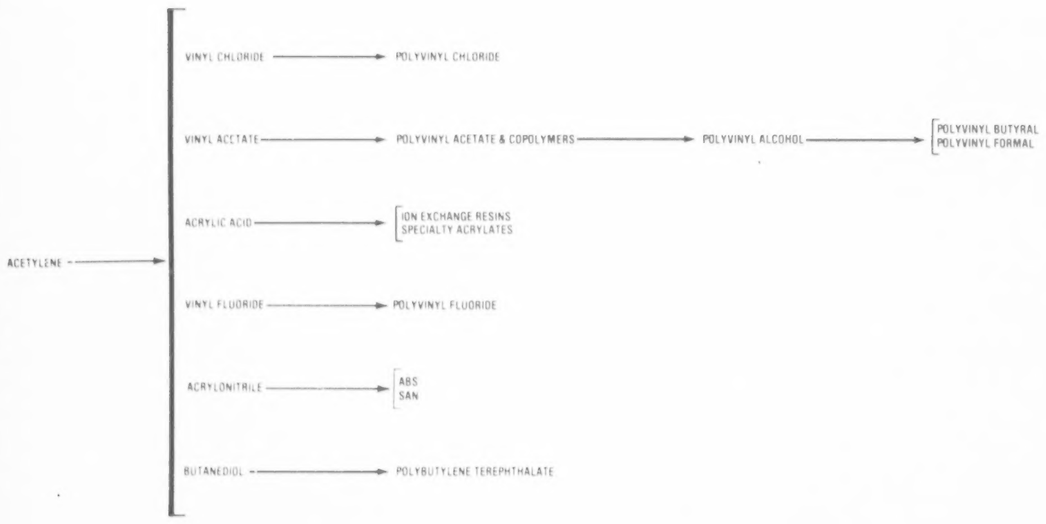
Plastics Derived from Methane



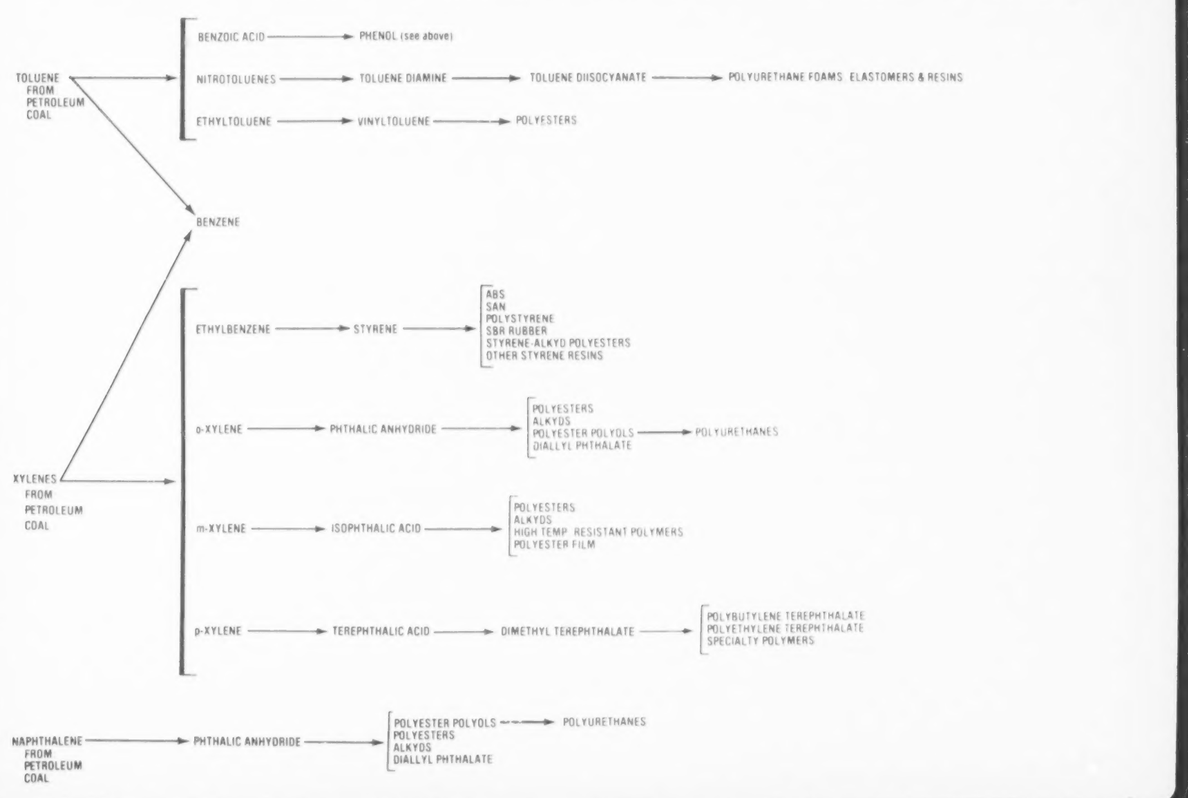
Plastics Derived from Benzene



Plastics Derived from Acetylene



Plastics Derived from Naphthalene, Toluene & Xylenes



COMMITTEE ON RESIN STATISTICS

SPI'S COMMITTEE ON RESIN STATISTICS

The Committee on Resin Statistics, only one of the more than fifty Operating Units within the Society of the Plastics Industry is composed of 100 representatives from plastics resin producing companies, trade publications, industry-related professional organizations, and various agencies of the Federal government. All members of the Committee are quite knowledgeable of the rapidly growing plastics industry and have a special interest in the development of marketing and economic data.

At present the Committee is responsible for the development and maintenance of a monthly report on the major plastics materials. This report shows monthly and cumulative data on Production and Sales & Use (including captive operations) with percent change from the previous year. It is the only detailed monthly report on plastics materials now available. There are one hundred twenty-five producers participating in the monthly program and they are believed to represent about 95% of total U.S. plastics production. Many of the materials covered reflect 100% industry coverage. The data are compiled by Ernst & Whinney, nationally renowned Independent Public Accountants.

The Committee is actively involved with the various departments of the Federal Government (International Trade Commission, Department of Commerce, Bureau of the Census, Bureau of Labor Statistics, etc.) assisting them in the development and improvement of the plastics segments of their special reports.

The Committee is also responsible for monitoring all resin data which appear in FACTS & FIGURES, thus assuring the most accurate and timely data available on the plastics industry.

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1984 edition

Facts & Figures of the U.S. Plastics Industry

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THE SOCIETY OF THE PLASTICS INDUSTRY, INC.

The Society of the Plastics Industry, Inc. is a member-run federation dedicated to promoting and protecting continuing growth for the plastics industry in the United States. The Society represents more than 1,600 member companies responsible for over 95 percent of plastics materials production.

SPI's 50 operating units and more than 300 committees have membership drawn from all segments of the industry—processors, resin and adjuvant suppliers, plastics distributors, machinery builders, and moldmakers. The Society serves as a federation of semi-autonomous, interrelated groups with a strong, common interest in the overall health of the plastics industry.

SPI serves as the "industry spokesman." It identifies and provides positive responses to misinformation and to potentially harmful regulations, bills, or court decisions by mobilizing pertinent facts and carrying out programs for timely and forceful action. At the same time, SPI works to prevent such damaging situations from occurring by building a positive understanding of the industry. The Society's service committees provide liaison with government agencies, code and regulatory groups, and many other associations.

SPI sponsors research projects in areas such as energy use, resource recovery, combustibility, and worker safety, at major private research organizations. The Society conducts numerous information programs, providtng literature, surveys, reports, newsletters, and handbooks for industry and public use.

SPI sponsors one of the largest trade shows in the United States—the National Plastics Exposition, held every three years. The next show will be held in June 1985, again at McCormick Place in Chicago.

Incorporated in 1937, SPI has grown with the dynamic industry it represents. In addition to the Society's headquarters office in New York City, SPI has four section offices: Eastern Section, 169 Union Boulevard, Totowa, NJ 07512; New England Section, 20 Speen Street, Framingham, MA 01701; Midwestern Section, 3150 Des Plaines Avenue, Des Plaines, IL 60018; and Western Section, Saddleback Square, Suite 124, 12440 Firestone Boulevard, Norwalk, CA 90650 plus a Washington, D.C. Office, 605 14th Street, N.W., Washington, D.C. 20005.

SPI draws together the diverse segments of the plastics industry into an effective organization that represents the entire industry.

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DEVELOPMENT OF TODAY'S PLASTICS

Today's plastics are one of the most used material on a volume basis in America's industrial and commercial life. The role of plastics is so broadly integrated in our own lifestyle that today there is virtually no product area where plastics do not make a major, irreplaceable contribution. Although the plastics industry in the United States is now in its second century, the most important developments have occurred since 1910. However, the roots of these modern developments go back not only to the research of cellulose nitrate by John Wesley Hyatt in the 1860's, but also to the plastic-like compositions used by man through the centuries.

ORIGIN OF PLASTICS

One can go as far back as the Old Testament to find references about natural materials used as fillers, adhesives, coatings, and the like. These materials were the precursors of what we call plastic materials today. Consequently, historians differ as to the exact date that the plastics industry began, and they will continue to do so since an exact year or even decade for the event is a matter of interpretation as to what constitutes a "plastic."

Certainly the history of the rubber industry has a bearing on plastics since ebonite, or hard rubber, discovered in 1851, was the first thermosetting material to be prepared and also the first material which involved a distinct chemical modification of a natural material. But ebonite was not exploited commercially for some years after its discovery and for that reason its historical importance has become somewhat blurred.

EUROPEAN DEVELOPMENTS

While the basic processes of rubber technology were developing, other important discoveries were taking place in Europe. Following work by Pelouze, Schonbein was able to establish conditions of controlled nitration of cellulose. The product soon became of interest as an explosive and in the manufacture of collodion, a cellulose solution in an alcohol-ether mixture. In the 1850's the English inventor Alexander Parkes observed that the solid residue left after the evaporation of the solvent of photographic collodion was a "hard, horny elastic and waterproof substance." In 1856 he patented the process of waterproofing woven fabrics by the use of such materials.

In 1862 the Great International Exhibition was held in London. It was there that Parkes introduced a new material named for himself—Parkesine. Parkesine was obtained by dissolving cellulose nitrate in a minimum of solvent. The mixture was then put on a heated rolling machine from which some of the solvent was then removed. While still in the plastic state the material was then shaped by dies or pressure. In 1866 Parkes organized the Parkesine Company to manufacture products from his new material, but the company failed in 1868. This appears in part due to Parkes' attempt to reduce production costs which resulted in the production of inferior items.

One year after the failure of the Parkesine Company, an associate of Parkes, Daniel Spill, formed the Xylonite Company to manufacture products similar to Parkesine. Once again economic failure resulted and Spill's company went bankrupt in 1874. Undaunted, Spill moved to a new site, established the Daniel Spill Company and continued production of his material, Xylonite.

FIRST PLASTICS IN THE U.S.

In the United States during the 1860's someone else was experimenting with cellulose nitrate—John Wesley Hyatt. In 1865 Hyatt became involved in devising a method for producing billiard balls from materials other than ivory. Originally using mixtures of cloth, ivory dust and shellac, in 1869 he patented the use of collodion for coating billiard balls. The patent came one year after his collodion material was introduced commercially.

John W. Hyatt and his brother Isaiah took out U.S. Patent 105,338 in 1870 for a process of producing a horn-like material using cellulose nitrate and camphor. Although Parkes and Spill had mentioned camphor in their work it was the Hyatt brothers who recognized the value of camphor as a plasticizer for cellulose nitrate. In 1872 the term celluloid was coined by Isaiah Hyatt to describe the Hyatts' commercially successful product.

The validity of Hyatts' patents was challenged by Spill and a number of court actions took place between 1877 and 1884. In the final action it was found that Spill had no claim on the Hyatt brothers, the judge ruling that the true inventor of the process was Parkes since he (Parkes) had mentioned the use of camphor in his patents. Thus, there was no restriction on the use of these processes and any company, including the Hyatts' Celluloid Manufacturing Company, were free to use them. After that decision the Celluloid Manufacturing Company prospered, changed its name to the American Celluloid Chemical Corporation, and eventually was absorbed by the Celanese Corporation.

FORMALDEHYDE RESINS

Next to cellulose nitrate the most important material in the early history of plastics was formaldehyde. Around 1897 there was a demand in German schools for a white chalkboard. Efforts to obtain such a product resulted in the discovery of casein plastics, produced by reacting casein (milk protein) with formaldehyde. The material soon became established under the trade names of Galalith and Erinoid, and today casein is still used by the button industry.

In 1899 Arthur Smith took out British Patent 16,274, the first dealing with phenol-formaldehyde resins, in this case for use as an ebonite substitute in electrical insulation. During the next decade the phenol-formaldehyde reaction was investigated mainly for academic interest. In 1907 however, Leo Hendrik Baekeland discovered techniques of so controlling and modifying the reaction that useful products could be made from it. Thus phenolics were the first fully synthetic resins to become commercially successful.

Prompted by the success of phenolic moldings, research began on reacting other materials, such as urea and thiourea, with formaldehyde. These materials were used in the manufacture of molding powders. Unlike the phenolics, they could be molded into light-colored articles and they rapidly achieved commercial success. Today these urea-based resins are used for molding powders, adhesives, and textile and paper finishing while the related melamine-formaldehyde resins are used in decorative laminates.

GROWTH OF MODERN PLASTICS

Cellulose acetate, a thermoplastic, was developed about the same time as the urea-based resins. Similar in structure to cellulose nitrate, it was found to be safer in processing and use. Cellulose acetate was introduced as a molding compound in 1927.

The period 1930-1940 saw the initial commercial development of today's major thermoplastics; polyvinyl chloride; low density polyethylene; polystyrene; and polymethyl methacrylate. The advent of the Second World War in 1939 brought plastics into great demand, largely as substitutes for materials in short supply, such as natural rubber. In the United States the crash program leading to large-scale production of synthetic rubbers resulted in extensive research into the chemistry of polymer formation, and eventually, to the development of more plastic materials.

The first decade after World War II saw the development of high density polyethylene and polypropylene and the growth of the newer plastics in many applications. Large-scale production of these materials reduced their cost dramatically. The new materials began to compete with the older plastics and even with the more traditional materials such as wood, paper, metal, glass and leather. Since that time the demand for plastics has increased steadily so that plastics are now accepted by designers and engineers as basic materials along with the more traditional materials. The automotive industry, for instance, relies on plastics to reduce weight and thus increase mileage.

INTRODUCTION OF PLASTICS RESINS

DATE	MATERIAL	EXAMPLE
1868	Cellulose Nitrate	Eye Glass Frames
1909	Phenol-Formaldehyde	Telephone Handset
1919	Casein	Knitting Needles
1926	Alkyd	Electrical Bases
1927	Cellulose Acetate	Tooth Brushes
1927	Polyvinyl Chloride	Wall Covering
1929	Urea-Formaldehyde	Lighting Fixtures
1935	Ethyl Cellulose	Flashlight Cases
1936	Acrylic	Brush Backs
1936	Polyvinyl Acetate	Flash Bulb Lining
1938	Cellulose Acetate Butyrate	Packaging
1938	Polystyrene	Housewares
1939	Nylon	Gears
1939	Polyvinylidene Chloride	Packaging Film
1939	Melamine-Formaldehyde	Tableware
1942	Unsaturated Polyester	Boat Hulls
1942	Low Density Polyethylene	Packaging
1943	Fluoropolymers	Industrial Gaskets
1943	Silicone	Motor Insulation
1945	Cellulose Propionate	Pens and Pencils
1947	Epoxy	Tools and Jigs
1948	Acrylonitrile-Butadiene-Styrene (ABS)	Luggage
1954	Styrene-Acrylonitrile (SAN)	Housewares
1954	Polyurethane	Foam Cushions
1956	Acetal	Automotive Parts
1957	High Density Polyethylene	Milk Bottles
1957	Polypropylene	Safety Helmets
1957	Polycarbonate	Appliance Parts
1959	Chlorinated Polyether	Valves and Fittings
1962	Phenoxy	Bottles
1964	Ionomer	Skin Packaging
1964	Polyphenylene Oxide	Battery Cases
1964	Polyimide	Bearings
1964	Ethylene-Vinyl Acetate	Adhesives and Coatings
1965	Polysulfone	Electrical/Electronic Parts
1970	Thermoplastic Polyester	Electrical/Electronic Parts
1973	Polybutylene	Piping
1973	Polyphenylene Sulfide	Telecommunications
1974	Polyethersulfone	Printed circuit boards
1975	Nitrile Barrier Resins	Non-food Packaging
1978	Linear Low Density Polyethylene	Extruded Film
1982	Polyetherimide	Electrical/Electronic Parts

1983 IN REVIEW—PRODUCTION AND SALES & CAPTIVE USE*

(in millions of pounds)

RESIN	PRODUCTION			SALES & CAPTIVE USE		
	1983	1982	%CHANGE	1983	1982	%CHANGE
Epoxy	334	286	16.8	331	301	10.0
Phenolic	2,484	2,006	23.8	2,529	2,060	22.8
Polyester	1,084	865	25.3	1,072	851	26.0
Urea	1,172	998	17.4	1,167	976	19.6
Melamine	180	158	13.9	181	155	16.8
Total Selected Thermosets	5,254	4,313	21.8	5,280	4,343	21.6
ABS	n.a.	740	—	n.a.	737	—
SAN	93	91	2.2	91	85	7.1
HDPE	5,691	4,928	15.5	5,707	5,024	13.6
LDPE	8,041	7,503	7.2	8,045	7,687	4.7
Nylon	321	228	40.8	329	247	33.2
Polypropylene	4,434	3,477	27.5	4,464	3,623	23.2
Polystyrene	3,567	3,191	11.8	3,606	3,200	12.7
PVC	6,066	5,326	13.9	6,152	5,455	12.8
Thermoplastic Polyester	778	648	20.1	783	619	26.5
Total Selected Thermoplastics	28,991	26,132	n.c.	29,177	26,677	n.c.
Total Selected Plastics	34,425	30,445	n.c.	34,457	31,020	n.c.
All Other Plastics	6,632	6,162	7.6	6,045	4,089	47.8
Grand Total	40,877	36,607	11.7	40,502	35,109	15.4

*Excludes Polyurethane. n.a. = not available n.c. = not comparable

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

1983 IN REVIEW— DISTRIBUTION OF SALES & CAPTIVE USE BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1983	1982	% CHANGE	SHARE OF TOTAL	
				1983	1982
Transportation	1,896	1,392	36.2	4.7%	4.0%
Packaging	11,813	10,497	12.5	29.2	29.9
Building/Construction	8,552	7,154	19.5	21.1	20.4
Electrical/Electronic	2,514	2,275	10.5	6.2	6.5
Furniture/Furnishings	2,007	1,556	29.0	5.0	4.4
Consumer/Institutional	3,816	3,269	16.7	9.4	9.3
Industrial/Machinery	318	241	32.0	0.8	0.7
Adhesives, Inks & Coatings	1,800	1,584	13.6	4.4	4.5
Other	3,636	3,232	12.5	9.0	9.2
Exports	4,150	3,909	6.2	10.2	11.1
Total	40,502	35,109	15.4	100.0%	100.0%

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

TOTAL U.S. PRODUCTION AND SALES & CAPTIVE USE OF PLASTICS RESIN: 1958-1983

(in millions of pounds)

YEAR	PRODUCTION (Excluding Polyurethane)	POLYURETHANE PRODUCTION[d]	PRODUCTION (Including Polyurethane)	SALES & CAPTIVE USE (Excluding Polyurethane)
[a]1958	4,578	33	4,611	4,003
1959	5,925	67	5,992	5,097
1960	6,226	95	6,321	5,277
1961	6,780	150	6,930	5,905
1962	7,977	220	8,197	6,952
[b]1963	9,084	280	9,364	7,380
1964	10,230	295	10,525	8,581
1965	11,829	390	12,219	10,684
1966	13,719	480	14,199	11,294
1967	13,923	550	14,473	11,789
1968	16,581	650	17,231	14,811
1969	18,935	785	19,720	15,788
1970	19,226	830	20,056	16,747
[c]1971	20,201	960	21,161	18,949
1972	25,285	1,190	26,475	24,433
1973	27,783	1,430	29,213	27,432
1974	27,944	1,330	29,274	26,693
1975	21,588	1,240	22,828	21,162
1976	27,646	1,550	29,196	26,984
1977	32,098	1,850	33,948	31,106
1978	35,655	1,950	37,605	35,063
1979	39,477	2,100	41,577	38,717
1980	35,447	1,900	37,347	35,186
1981	37,817	2,050	39,867	36,956
1982	34,907	1,700	36,607	35,109
1983	40,877	1,900	42,777	40,502

[a]U.S. Tariff Commission data used for 1958-1970. May exclude some captive use.
[b]Cellulosics not included through 1962. Included beginning in 1963.
[c]SPI data used for 1971-1983
[d]***Chemical Economics Handbook,*** SRI International, Menlo Park, Cal.

	Compound Growth Rate	
Years	Total Production	Sales & Captive Use
1958-1983	9.3%	9.7%
1968-1983	6.3%	6.9%
1973-1983	3.9%	4.0%
1978-1983	2.6%	2.9%
1982-1983	16.9%	15.4%

TOTAL U.S. PLASTICS PRODUCTION AND SALES & CAPTIVE USE BY RESIN*

(in millions of pounds)

RESIN	1974		1975		1976		1977		1978	
	P	S & CU	P	S & CU	P	S & CU	P	S & CU	P	S & CU
Epoxy	249	240	198	187	244	250	261	278	299	316
Phenolic	1,355	1,305	1,051	1,034	1,340	1,305	1,458	1,400	1,617	1,543
Polyester	911	907	834	771	1,042	959	1,061	1,045	1,209	1,199
Urea	835	822	690	685	821	809	963	951	1,122	1,103
Melamine	164	156	115	117	186	182	200	203	202	196
Total Selected Thermosets	3,494	3,430	2,888	2,794	3,633	3,505	3,943	3,877	4,449	4,357
ABS	857	816	642	621	988	925	1,069	1,057	1,134	1,118
SAN	109	119	109	75	113	104	115	113	120	121
HDPE	2,837	2,676	2,468	2,305	3,125	3,127	3,652	3,557	4,201	4,165
LDPE	5,973	5,998	4,743	4,725	5,813	5,765	6,471	6,488	7,111	7,147
Nylon	204	183	135	143	247	221	254	250	275	278
Polypropylene	2,249	2,200	1,902	1,903	2,632	2,536	2,747	2,698	3,074	3,055
Polystyrene	3,364	3,203	2,662	2,640	3,195	3,145	3,446	3,557	3,823	3,870
PVC	4,850	4,711	3,648	3,615	4,716	4,638	5,253	5,232	5,723	5,810
Thermoplastic Polyester	—	—	—	—	—	—	—	—	—	—
Total Selected Thermoplastics	20,443	19,906	16,310	16,027	20,829	20,461	23,007	22,952	25,461	25,564
Total Selected Plastics	23,397	23,338	19,198	18,821	24,462	23,966	26,950	26,829	29,910	29,921
All Other Plastics	5,337	3,355	3,630	2,341	4,734	3,018	6,998	4,227	7,695	5,142
Grand Total	29,274	26,693	22,828	21,162	29,196	26,984	33,948	31,106	37,605	35,063

P = Production S & CU = Sales & Captive Use

*Sales & Captive Use excludes Polyurethane.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

TOTAL U.S. PLASTICS PRODUCTION AND SALES & CAPTIVE USE BY RESIN* (Cont'd)

(in millions of pounds)

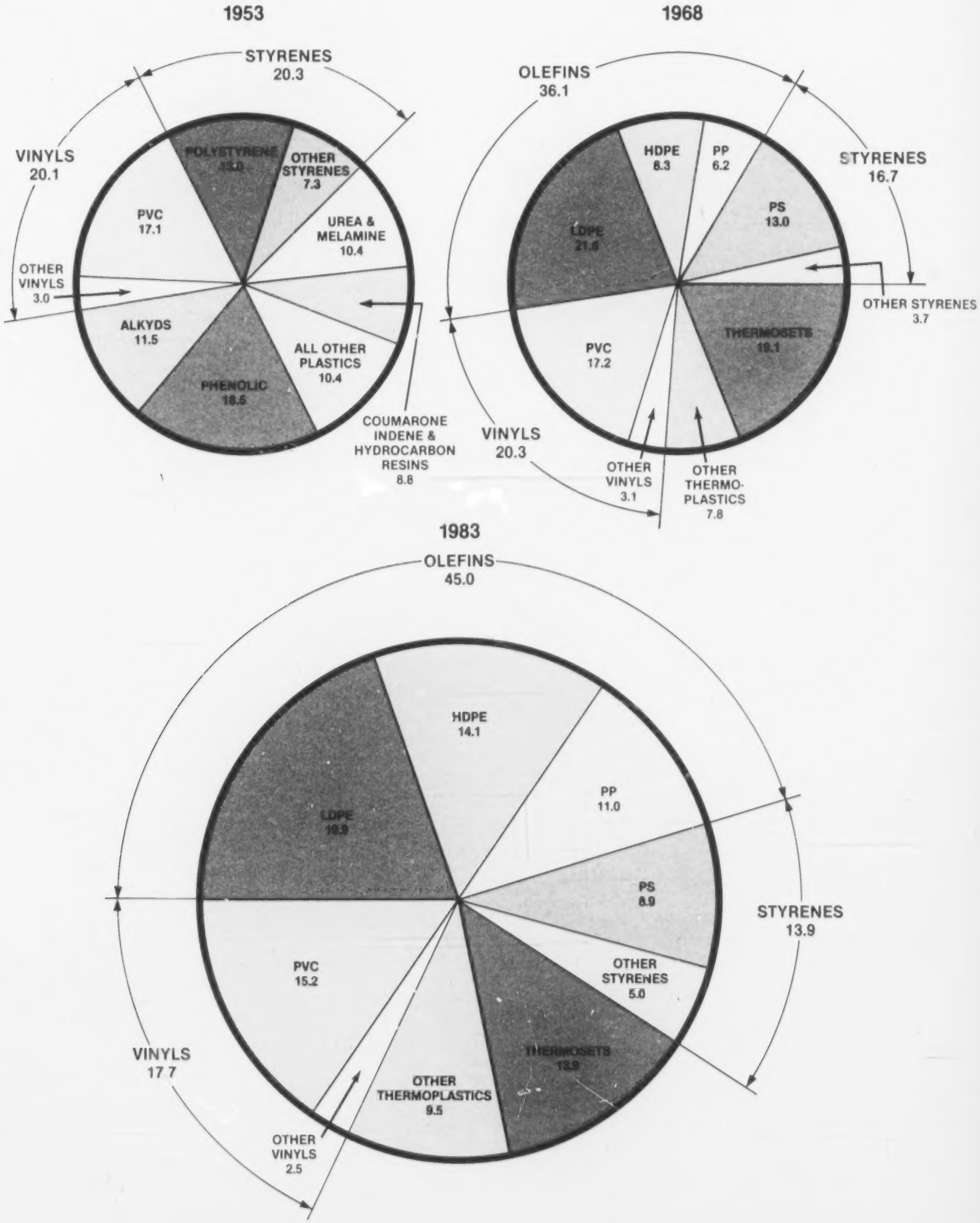
1979		1980		1981		1982		1983		Compound Growth Rate 1974-1983
P	S & CU	P	S & CU	P	S & CU	P	S & CU	P	S & CU	S & CU
361	332	315	319	336	332	286	301	334	331	6.6%
1,781	1,732	1,499	1,517	2,333	2,375	2,006	2,060	2,484	2,529	**
1,147	1,152	947	949	997	977	865	851	1,084	1,072	3.4
1,367	1,355	1,165	1,147	1,165	1,139	998	976	1,172	1,167	7.3
200	192	167	166	179	175	158	155	180	181	3.0
4,856	4,763	4,093	4,098	5,010	4,998	4,313	4,343	5,254	5,280	**
1,191	1,183	920	916	916	900	740	737	n.a.	n.a.	—
124	126	111	103	107	105	91	85	93	91	– 5.2
5,010	4,893	4,405	4,394	4,695	4,683	4,928	5,024	5,691	5,707	16.4
7,793	7,815	7,291	7,467	7,693	7,516	7,503	7,687	8,041	8,045	6.0
327	315	274	271	312	288	228	247	321	329	12.5
3,841	3,894	3,648	3,714	3,955	3,888	3,477	3,623	4,434	4,464	15.2
4,005	3,997	3,521	3,518	3,621	3,604	3,191	3,200	3,567	3,606	2.4
6,119	6,138	5,470	5,407	5,707	5,601	5,326	5,455	6,066	6,152	13.9
—	—	503	511	610	581	648	619	778	783	—
28,410	28,361	26,143	26,301	27,616	27,166	26,132	26,677	28,991	29,177	8.0
33,266	33,124	30,236	30,399	32,626	32,164	30,445	31,020	34,245	34,457	8.1
8,311	5,593	7,111	4,786	7,241	4,792	6,162	4,089	6,632	6,045	12.5
41,577	38,717	37,347	35,185	39,867	36,956	36,607	35,109	40,877	40,502	8.7%

P = Production S & CU = Sales & Captive Use n.a. = not available.

*Sales & Captive Use excludes Polyurethane. **Not applicable since reporting on gross weight basis begun in 1981.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

PERCENTAGE DISTRIBUTION OF PLASTIC SALES & CAPTIVE USE BY MATERIAL



PLASTICS RESINS DOMESTIC MERCHANT SALES

(in millions of dollars and millions of pounds)

RESIN	1983		1982		% CHANGE	
	Net Dollar Value	Quantity	Net Dollar Value	Quantity	Net Dollar Value	Quantity
Low Density Polyethylene	$ 2,836	6,322	$ 1,756	5,815	+ 35.9	+ 8.7
High Density Polyethylene	1,501	4,606	1,350	4,106	+ 11.2	+ 12.2
Polyvinyl Chloride	1,609	4,937	1,031	4,353	+ 56.1	+ 13.4
Polystyrene	1,375	3,190	1,210	2,766	+ 13.6	+ 15.3
Polypropylene	1,054	2,941	923	2,430	+ 14.2	+ 21.0
ABS	728	924	530	685	+ 37.4	+ 34.9
Unsaturated Polyester	631	1,053	508	835	+ 24.2	+ 26.1
Other Styrenes	544	781	395	524	+ 37.7	+ 49.0
Thermoplastic Polyester	534	697	391	563	+ 36.6	+ 23.8
Nylon	431	282	315	208	+ 36.8	+ 35.6
Epoxy	415	296	317	262	+ 30.9	+ 13.0
Phenolic	378	1,760	328	1,394	+ 15.2	+ 26.3
Urea	206	1,044	176	868	+ 17.0	+ 20.3
Other Vinyls	149	92	114	81	+ 30.7	+ 13.6
Melamine	125	138	100	123	+ 25.0	+ 12.2
SAN	54	75	51	72	+ 5.9	+ 4.2
All other (excluding polyvinyl acetate and polyurethane)	3,437	2,168	2,870	1,843	+ 19.8	+ 17.6
Total	$15,557	31,306	$12,365	26,928	+ 25.8	+ 16.3

Domestic merchant sales are quantities of sales excluding interplant transfers, captive consumption and exports.

Net dollar value represents the actual selling price after deductions for cash discounts, quantity discounts, returned goods and allowances, federal excise taxes, local taxes, and outgoing transportation (prepaid or otherwise) to warehouses or customers.

Source: SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

APPARENT U.S. CONSUMPTION OF SELECTED PLASTICS RESINS

Apparent consumption is calculated by adding imports to production then subtracting exports. It is an accurate measure of the quantity of material actually consumed in the United States.

For purposes of the table below, the production figures were taken from SPI's Monthly Statistical Report, as compiled by Ernst & Whinney. Both the import and export figures were taken from Bureau of the Census reports.

1983
(in millions of pounds)

RESIN	PRODUCTION	IMPORTS	EXPORTS	APPARENT CONSUMPTION
Low Density Polyethylene	8,041	99	844	7,296
Polyvinyl Chloride	6,066	182	404	5,844
High Density Polyethylene	5,691	31	1,177	4,545
Polystyrene & Styrene Copolymers (inc. ABS)	5,553	80	152	5,481
Polypropylene	4,434	10	778	3,666
Phenolic	2,484	27	42	2,469
Urea	1,172	15	9	1,178
Unsaturated Polyester	1,084	8	30	1,062
Other Vinyls	1,007	64	128	943
Thermoplastic Polyester[a]	778	26	68	736
Epoxy	334	6	91	249
Nylon	321	31	28	324
Melamine	180	2	16	166
Total of these resins	37,145	581	3,767	33,959
1982 Total	31,262	268	4,102	27,428
1981 Total	33,696	307	3,596	30,407
1980 Total	31,247	247	4,194	27,300
1979 Total	34,550	273	3,625	31,198
1978 Total	31,101	234	2,302	29,033
1977 Total	28,077	136	1,978	26,235
1976 Total	25,565	135	2,185	23,515

[a]Not included in total 1976-1979.

Source: Production—SPI Monthly Statistical Report, as compiled by Ernst & Whinney
Imports—Bureau of the Census, IM 146
Exports—Bureau of the Census, EM 546

PLASTICS MATERIALS & RESINS
VALUE OF SHIPMENTS

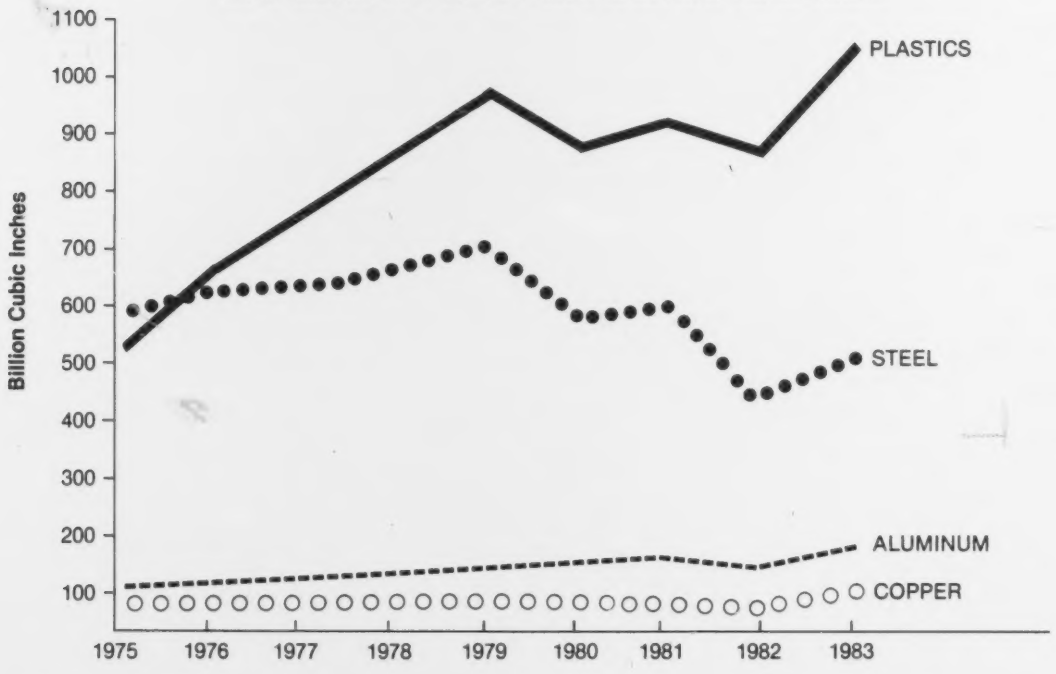
(in millions of dollars)

VERSUS LARGEST CHEMICAL CATEGORIES	1979	1980	1981	1982	1983	COMPOUND GROWTH RATE 1978-1983
Industrial Organic Chemicals	32,700	33,825	38,450	34,250	34,000	5.2%
Drugs	17,300	19,900	22,300	25,150	27,650	11.1%
Plastics Materials & Resins	**14,300**	**14,900**	**16,700**	**15,450**	**17,350**	**7.7%**
Industrial Inorganic Chemicals	10,600	12,100	12,800	12,400	10,850	2.1%
Soaps & Detergents	6,900	8,300	9,100	9,900	10,800	11.0%
Cosmetics	7,400	7,900	8,700	9,400	10,250	7.3%
Paints & Allied Products	7,900	8,350	9,150	8,900	9,600	6.1%
Cyclic Crudes & Intermediates	6,250	7,580	8,050	7,100	6,750	3.4%
Fertilizers	6,150	7,900	8,000	6,750	5,900	1.4%
Polishes & Sanitation Goods	3,700	4,150	4,750	5,150	5,650	22.0%

VERSUS OTHER COMMODITIES	1979	1980	1981	1982	1983	COMPOUND GROWTH RATE 1978-1983
Steel	65,950	60,200	68,950	50,900	60,450	0.8%
Paper and Board	25,450	28,700	31,950	30,450	33,350	7.8%
Aluminum	18,900	19,900	20,500	14,700	21,100	5.8%
Cement and Concrete	18,150	18,000	17,950	16,800	18,250	2.7%
Plastics Materials & Resins	**14,300**	**14,900**	**16,700**	**15,450**	**17,350**	**7.7%**
Glass Containers	4,200	4,500	4,900	5,200	5,500	6.5%
Primary Copper	5,750	5,500	5,400	3,600	4,400	0.9%
Synthetic Rubber	2,650	2,650	3,000	2,700	2,700	6.2%
Leather Tanning & Finishing	1,800	1,800	1,900	1,800	1,900	3.8%

Source: Department of Commerce estimates.

SHIPMENTS BY VOLUME: PLASTICS VS METALS



NOTE: Factors used in conversion—steel = .289 lbs/cu in
plastics = .04 lbs/cu in
aluminum = .098 lbs/cu in
copper = .321 lbs/cu in

NOTE: Plastics do not include polyurethane
SOURCE: American Iron and Steel Institute
SPI
U.S. Bureau of the Census

PLASTICS MATERIALS AND RESINS (SIC 2821)

(in millions of dollars except as noted)

ITEM	1972	1977	1979	1981	1982[1]	1983[2]	AAG 1972-83	1984[3]	% CHANGE 1983-84
Industry data									
Value of shipments[4]	4,478.2	10,818.2	14,282.4	16,675.5	15,460.0	17,340.0	13.1	—	—
Value of shipments (1972 $)[4]	4,478.2	5,060.0	5,603.1	5,329.3	5,040.0	5,545.0	2.0	5,930.0	6.9
Total employment (000)	54.8	57.2	60.3	57.7	55.2	53.6	−0.2	54.1	0.9
Production workers (000)	35.0	36.7	38.4	35.8	33.9	33.0	−0.5	33.2	0.6
Average hourly earnings of production workers ($)	4.98	7.52	8.86	10.77	11.71	12.66	8.9	—	—
Capital expenditures	253.2	895.2	1,077.1	904.2	—	—	—	—	—
Product data									
Value of shipments[5]	4,486.4	12,181.1	16,964.2	20,172.3	18,180.0	20,400.0	14.8	—	—
Value of shipments (1972 $)[5]	4,486.4	5,546.9	6,487.3	6,319.6	5,930.0	6,520.0	3.5	6,970.0	6.9
Product price index (1972 = 100)	100.0	219.5	261.5	319.1	313.8	312.8	10.9	—	—
Quantity produced (million lbs.)	25,921.0	34,623.0	41,871.0	40,600.0	38,000.0	41,900.0	4.5	45,000.0	7.4
Trade									
Value of exports	438.9	1,057.2	2,183.3	2,552.5	2,471.7	2,315.0	16.3	2,400.0	3.7
Value of imports	56.4	106.3	246.4	315.7	292.0	375.0	18.8	430.0	14.7
Export/shipments ratio	0.093	0.081	0.120	0.118	0.136	0.113	—	—	—
Import/new supply ratio[6]	0.010	0.007	0.012	0.013	0.016	0.018	—	—	—

[1] Estimated except for product price index, exports, and imports.
[2] Estimated.
[3] Forecast.
[4] Value of all products and services sold by industry SIC 2821.
[5] Value of shipments of plastics materials and resins products produced by all industries.
[6] New supply is the sum of product shipments plus imports.

Source: Bureau of the Census and Bureau of Industrial Economics. Estimates and forecasts by the Bureau of Industrial Economics.

MISCELLANEOUS PLASTICS PRODUCTS (SIC 3079)

(in millions of dollars except as noted)

ITEM	1972	1977	1979	1981	1982[1]	1983[2]	AAG 1972-83	1984[3]	% CHANGE 1983-84
Industry data									
Value of shipments[4]	10,695.9	23,692.6	29,116.2	34,121.6	33,610.0	37,000.0	11.9	—	—
Value of shipments (1972 $)[4]	10,695.9	14,571.1	15,620.3	15,760.6	15,200.0	16,600.0	4.1	17,900.0	7.8
Total employment (000)	346.9	453.7	487.7	469.5	449.3	452.2	2.4	465.0	2.8
Production workers (000)	276.4	358.0	386.8	369.5	349.7	353.0	2.2	365.0	3.4
Average hourly earnings of production workers ($)	3.27	4.66	5.29	6.20	6.60	7.03	7.2	—	—
Capital expenditures	654.0	1,154.2	1,503.1	1,557.9	—	—	—	—	—
Product data									
Value of shipments[5]	11,094.4	23,878.7	29,347.9	34,152.2	33,650.0	37,000.0	11.6	—	—
Value of shipments (1972 $)[5]	11,094.4	14,685.5	15,744.6	15,774.7	15,225.0	16,600.0	3.7	17,900.0	7.8
Product price index (1972 = 100)	100.0	166.4	192.1	225.2	232.8	223.0	7.6	—	—
Trade									
Value of exports	377.0	918.0	1,500.0	1,932.0	1,861.0	1,900.0	15.8	—	—
Value of imports	253.0	507.0	798.0	950.0	1,020.0	1,000.0	13.3	—	—
Export/shipments ratio	0.034	0.038	0.051	0.057	0.055	0.051	—	—	—
Import/new supply ratio[6]	0.022	0.021	0.026	0.027	0.029	0.026	—	—	—

[1] Estimated except for product price index, exports, and imports.
[2] Estimated.
[3] Forecast.
[4] Value of all products and services sold by industry SIC 3079.
[5] Value of shipments of miscellaneous plastics products produced by all industries.
[6] New supply is the sum of product shipments plus imports.

Source: Bureau of the Census and Bureau of Industrial Economics. Estimates and forecasts by the Bureau of Industrial Economics.

Source: *1983 U.S. Industrial Outlook*, U.S. Department of Commerce.

GENERAL ECONOMIC STATISTICS

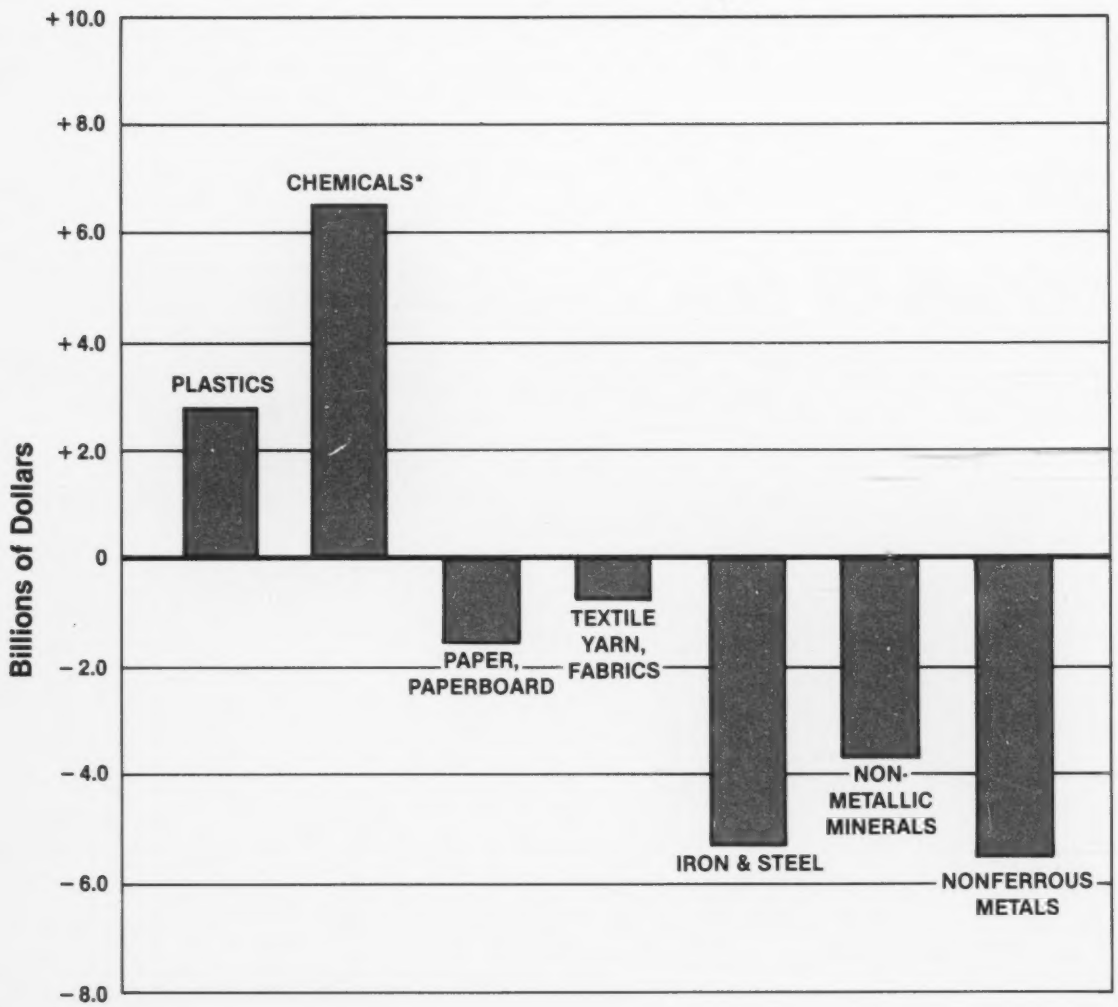
COMMODITY — BALANCE OF TRADE

(in millions of dollars)

	EXPORTS	IMPORTS	DIFFERENCE
Plastics Materials & Resins			
1979	3,240	641	+ 2,599
1980	3,884	652	+ 3,232
1981	3,809	779	+ 3,030
1982	3,650	766	+ 2,884
1983	3,732	1,098	+ 2,634
Chemicals (except plastics)			
1979	14,066	6,877	+ 7,189
1980	16,356	7,891	+ 8,465
1981	17,378	8,543	+ 8,835
1982	16,240	8,727	+ 7,513
1983	16,019	9,681	+ 6,338
Paper, Paperboard			
1979	1,967	3,331	– 1,364
1980	2,831	3,534	– 703
1981	2,961	3,822	– 861
1982	2,653	3,848	– 1,195
1983	2,553	4,215	– 1,662
Textile Yarn, Fabrics			
1979	3,189	2,237	+ 952
1980	3,632	2,504	+ 1,128
1981	3,619	3,043	+ 576
1982	2,784	2,807	– 23
1983	2,368	3,225	– 857
Iron and Steel			
1979	2,342	7,620	– 5,278
1980	3,122	7,509	– 4,387
1981	2,880	11,238	– 8,358
1982	1,804	4,487	– 2,683
1983	1,478	6,791	– 5,313
Nonmetallic Minerals, n.e.c.			
1979	1,949	4,065	– 2,116
1980	2,209	4,680	– 2,471
1981	2,194	4,890	– 2,696
1982	2,168	9,612	– 7,444
1983	1,770	5,330	– 3,560
Nonferrous Metals			
1979	2,152	6,314	– 4,162
1980	4,743	7,612	– 2,869
1981	2,594	6,947	– 4,353
1982	2,094	5,320	– 3,226
1983	2,033	7,422	– 5,389

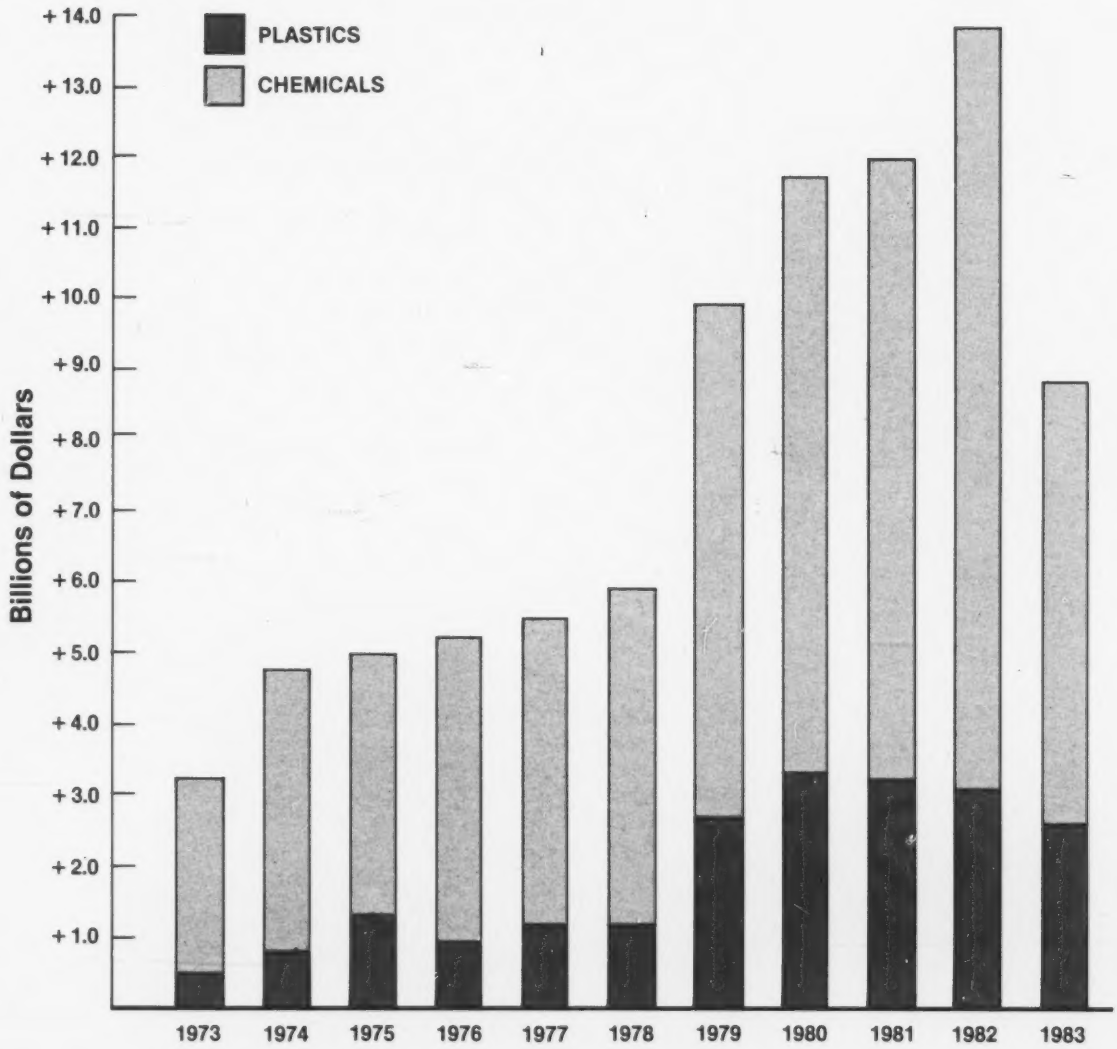
Source: U.S. Dept. of Commerce; FT 135(U.S. Imports), FT 410(U.S. Exports)

U.S. BALANCE OF TRADE—1983



Source: Department of Commerce
*Chemicals exclude plastics

PLASTICS & CHEMICALS BALANCE OF TRADE 1973-1983



PRODUCER PRICE INDEXES
[1967 = 100]

YEAR	COMMODITY GROUP					
	NON-METALLIC MINERAL PRODUCTS	METALS & METAL PRODUCTS	INDUSTRIAL COMMODITIES	CHEMICALS & ALLIED PRODUCTS	PLASTICS RESINS & MATERIALS	PULP, PAPER & ALLIED PRODUCTS
1968	103.7	102.6	102.5	99.8	91.9	101.1
1969	107.7	108.5	106.0	99.9	90.4	104.0
1970	113.3	116.7	110.0	102.2	90.7	108.2
1971	122.4	119.0	114.0	104.2	88.9	110.1
1972	126.1	123.5	117.9	104.2	88.7	113.4
1973	130.2	132.8	125.9	110.0	92.1	122.1
1974	153.2	171.9	153.8	146.8	143.8	151.7
1975	174.0	185.6	171.5	181.3	180.9	170.4
1976	186.3	195.9	182.4	187.2	194.0	179.4
1977	200.5	209.0	195.1	192.8	197.5	186.4
1978	228.8	227.1	209.4	198.8	199.9	195.6
1979	248.6	259.3	236.5	222.3	235.9	219.0
1980	282.9	286.4	274.3	260.3	279.5	249.2
1981	309.5	300.4	304.1	287.7	289.2	273.8
1982	318.6	302.0	312.4	292.3	283.3	288.7
1983	325.3	307.1	315.8	292.9	290.2	297.7

PROFILE OF 50 BIGGEST MANUFACTURING INDUSTRIES

1983 RANK	SIC	INDUSTRY	SHIPMENTS ($ MIL.) 1983	1982	TOTAL PLANTS 1983	1982
1	2911	Petroleum refining	$181,383	$191,772	366	352
2	3711	Motor vehicles & car bodies	101,531	75,271	188	179
3	2011	Meat-packing plants	44,155	49,264	1,007	1,002
4	3714	Motor-vehicle parts & accessories	42,500	37,370	1,278	1,249
5	3573	Electronic computing equipment	39,347	28,719	1,263	1,214
6	3312	Blast furnaces & steel mills	37,640	38,264	381	357
7	2869	Industrial organic chemicals, N.E.C.	36,770	32,112	553	525
8	3662	Radio & TV communication equipment	32,673	29,496	1,272	1,215
9	3721	Aircraft	32,020	29,419	126	123
10	**3079**	**Miscellaneous plastics products**	**28,894**	**27,282**	**5,134**	**4,892**
11	2711	Newspapers	21,331	20,027	2,577	2,458
12	2621	Paper mills, except bldg. paper	20,860	18,637	353	343
13	3861	Photographic equip. & supplies	18,122	17,436	425	397
14	2834	Pharmaceutical preparations	17,952	17,426	496	464
15	**2821**	**Plastics materials & resins**	**17,495**	**16,487**	**498**	**484**
16	2086	Bottled & canned soft drinks	17,140	15,587	1,642	1,607
17	2026	Fluid milk	17,105	18,828	975	972
18	3661	Telephone & telegraph apparatus	15,996	15,243	248	228
19	3724	Aircraft engines & engine parts	15,180	13,211	173	163
20	2752	Commercial printing, lithographic	14,771	15,190	1,990	1,904
21	3674	Semiconductors & related devices	13,443	11,092	387	315
22	2111	Cigarettes	13,094	10,886	10	10
23	2051	Bread, cake, & related products	12,501	11,394	1,423	1,376
24	3585	Refrigeration & heating equipment	12,443	12,509	565	551
25	3679	Electronic components, N.E.C.	12,366	—	1,799	—
26	2421	Sawmills & planing mills, general	12,302	12,463	2,024	1,957
27	3531	Construction machinery	12,051	16,201	530	516
28	2082	Malt beverages	11,935	10,507	79	83
29	2819	Industrial inorganic chem., N.E.C.	11,708	11,487	622	599
30	2631	Paperboard mills	11,056	10,040	205	203
31	2721	Periodicals	10,743	10,018	966	929
32	2013	Sausage & other prepared meats	10,632	11,983	803	760
33	3011	Tires and inner tubes	10,501	—	129	—
34	2653	Corrugated & solid fiber boxes	10,335	10,175	1,129	1,100
35	2824	Organic fibers, noncellulosic	10,214	9,433	55	58
36	3411	Metal cans	9,785	9,558	335	336
37	2022	Cheese, natural & processed	9,663	10,103	340	327
38	3443	Fabricated plate work, boiler shops	9,545	9,514	1,337	1,262
39	2647	Sanitary paper products	9,519	8,689	109	107
40	3728	Aircraft equipment, N.E.C.	9,459	10,139	635	606
41	3523	Farm machinery & equipment	9,414	10,237	893	873
42	3761	Guided missiles & space vehicles	9,264	9,079	68	72
43	2016	Poultry dressing plants	9,204	9,409	308	297
44	2033	Canned fruits & vegetables	9,152	—	674	—
45	2099	Food preparations, N.E.C.	9,144	—	793	—
46	2841	Soap & other detergents	8,986	9,220	284	274
47	3519	Internal combustion engines, N.E.C.	8,985	10,541	146	137
48	2851	Paints & allied products	8,928	9,227	918	886
49	2221	Weaving mills, synthetics	8,891	—	346	—
50	3599	Machinery, Exc. electrical, N.E.C.	8,890	12,432	3,423	3,259
		50-industry total	$1,068,025	$1,019,306	42,280	41,971

n.e.c.: not elsewhere classified.

Definitions: Shipments: Output of all manufacturing plants. No. of Plants: Manufacturing establishments with 20 or more employees.

Sources: *Sales & Marketing Management's 1984 Survey of Industrial Purchasing Power,* U.S. Commerce Dept., *U.S. Industrial Outlook 1984.*

INDUSTRY FINANCIAL PERFORMANCE — 1983

RETURN ON SALES

THE INDUSTRY MEDIANS

	1983	1982
Pharmaceuticals	10.4%	9.9%
Publishing, printing	7.5	6.5
Mining, crude-oil production	6.1	3.0
Beverages	6.0	5.4
Office equipment (includes computers)	5.7	5.7
Soaps, cosmetics	5.5	5.2
Measuring, scientific, photographic equipment	5.1	5.9
Electronics, appliances	4.8	4.5
Metal products	4.0	3.7
Paper, fiber, and wood products	3.7	3.2
Motor vehicles	3.7	2.1
Aerospace	3.6	2.8
Apparel	3.6	3.4
Chemicals	3.5	3.9
Petroleum refining	3.4	4.0
Glass, concrete, abrasives, gypsum	3.4	1.5
Textiles, vinyl flooring	3.2	2.1
Rubber, plastic products	3.1	0.9
Shipbuilding, railroad and transportation equipment	2.9	2.8
Food	2.7	3.3
Industrial and farm equipment	1.8	3.2
Musical instruments, toys, sporting goods	0	N.A.
Metal manufacturing	0	0
Leather	N.A.	N.A.
Jewelry, silverware	N.A.	N.A.
Tobacco	N.A.	N.A.
Furniture	N.A.	N.A.
All Industries	3.8	3.6
Custom Processors		2.0
Proprietary Processors		3.1
All Processors		2.5

SALES PER EMPLOYEE

THE INDUSTRY MEDIANS

Petroleum refining	$481,410
Mining, crude-oil production	172,661
Beverages	142,258
Food	130,493
Chemicals	123,779
Soaps, cosmetics	113,135
Metal manufacturing	109,728
Paper, fiber, and wood products	107,457
Rubber, plastic products	99,009
Glass, concrete, abrasives, gypsum	93,035
Pharmaceuticals	90,208
Publishing, printing	87,972
Shipbuilding, railroad and transportation equipment	87,907
Motor vehicles	86,260
Metal products	83,471
Industrial and farm equipment	79,024
Musical instruments, toys, sporting goods	77,238
Aerospace	77,174
Measuring, scientific, photographic equipment	70,127
Electronics, appliances	67,615
Office equipment (includes computers)	66,423
Textiles, vinyl flooring	55,336
Apparel	48,618
Furniture	N.A.
Leather	N.A.
Tobacco	N.A.
All Industries	92,226
Custom Processors	55,290
Proprietary Processors	66,460
All Processors	59,690

CHANGES IN SALES

THE INDUSTRY MEDIANS

INCREASES	
Motor vehicles	16.9 %
Publishing, printing	12.1
Musical instruments, toys, sporting goods	11.3
Paper, fiber, and wood products	10.6
Aerospace	9.5
Office equipment (includes computers)	8.5
Beverages	7.2
Pharmaceuticals	6.4
Electronics, appliances	5.7
Textiles, vinyl flooring	5.7
Chemicals	4.0
Glass, concrete, abrasives, gypsum	3.9
Rubber, plastic products	3.7
Soaps, cosmetics	2.9
Shipbuilding, railroad and transportation equipment	2.7
Metal products	2.2
Food	1.9
Metal manufacturing	1.7
Mining, crude-oil production	.5
Apparel	.3
DECREASES	
Industrial and farm equipment	7.7 %
Petroleum refining	4.6
Measuring, scientific, photographic equipment	1.9
Jewelry, silverware	N.A.
Leather	N.A.
Furniture	N.A.
Tobacco	N.A.
Custom Processors	+ .3
Proprietary Processors	+ 2.1
All Processors	+ 0.6

TOTAL RETURN TO INVESTORS

THE INDUSTRY MEDIANS

Beverages	48.63%
Motor vehicles	42.75
Metal manufacturing	42.50
Apparel	41.64
Shipbuilding, railroad and transportation equipment	39.44
Mining, crude-oil production	36.79
Chemicals	34.41
Industrial and farm equipment	34.39
Paper, fiber, and wood products	34.12
Metal products	33.07
Aerospace	32.91
Textiles, vinyl flooring	32.25
Office equipment (includes computers)	28.75
Publishing, printing	27.07
Electronics, appliances	26.84
Food	26.02
Measuring, scientific, photographic equipment	23.79
Petroleum refining	22.39
Rubber, plastic products	13.69
Glass, concrete, abrasives, gypsum	9.46
Pharmaceuticals	7.18
Soaps, cosmetics	6.78
Musical instruments, toys, sporting goods	2.08
Leather	N.A.
Jewelry, silverware	N.A.
Tobacco	N.A.
Furniture	N.A.
All Industries	30.21
Custom Processors	7.3
Proprietary Processors	9.8
All Processors	8.5

Source: "The Fortune Directory of the 500 Largest U.S. Industrial Corporations"
SPI Financial Management Committee, Financial and Operating Ratios Survey

TOTAL RETURN TO INVESTORS 1973-83

THE INDUSTRY MEDIANS

Aerospace	25.45%
Apparel	24.75
Publishing, printing	21.17
Shipbuilding, railroad and transportation equipment	20.08
Textiles, vinyl flooring	18.89
Metal products	16.69
Motor vehicles	16.62
Glass, concrete, abrasives, gypsum	16.60
Food	16.42
Paper, fiber, and wood products	15.94
Electronics, appliances	15.37
Industrial and farm equipment	14.75
Rubber, plastic products	14.22
Chemicals	14.02
Mining, crude-oil production	13.74
Musical instruments, toys, sporting goods	13.43
Petroleum refining	12.02
Metal manufacturing	11.83
Beverages	11.23
Office equipment (includes computers)	11.22
Measuring, scientific, photographic equipment	8.00
Pharmaceuticals	6.38
Soaps, cosmetics	4.15
Jewelry, silverware	N.A.
Leather	N.A.
Tobacco	N.A.
Furniture	N.A.
All Industries	14.59
Custom Processors	– 25.2 (1972-82)
Proprietary Processors	– 33.6 (1972-82)
All Processors	– 29.8 (1972-82)

ASSETS PER EMPLOYEE

THE INDUSTRY MEDIANS

Petroleum refining	$431,817
Mining, crude-oil production	290,032
Chemicals	120,977
Metal manufacturing	113,559
Paper, fiber, and wood products	108,792
Beverages	90,046
Pharmaceuticals	82,330
Publishing, printing	76,706
Glass, concrete, abrasives, gypsum	73,055
Soaps, cosmetics	72,634
Office equipment (includes computers)	67,300
Industrial and farm equipment	64,642
Aerospace	63,964
Metal products	61,027
Motor vehicles	60,718
Food	60,680
Rubber, plastic products	54,695
Measuring, scientific, photographic equipment	54,404
Electronics, appliances	53,509
Musical instruments, toys, sporting goods	52,690
Shipbuilding, railroad and transportation equipment	42,787
Textiles, vinyl flooring	34,898
Apparel	26,370
Furniture	N.A.
Tobacco	N.A.
Leather	N.A.
Jewelry, silverware	N.A.
All Industries	70,238
Custom Processors	30,065
Proprietary Processors	38,865
All Processors	33,069

CHANGES IN PROFITS

THE INDUSTRY MEDIANS

	INCREASES
Rubber, plastic products	171.5%
Motor vehicles	118.6
Glass, concrete, abrasives, gypsum	78.3
Metal manufacturing	27.0
Chemicals	26.9
Aerospace	23.6
Apparel	23.2
Beverages	23.0
Paper, fiber, and wood products	22.4
Textiles, vinyl flooring	22.2
Publishing, printing	21.0
Pharmaceuticals	13.5
Metal products	13.0
Shipbuilding, railroad and transportation equipment	10.8
Electronics, appliances	9.7
Food	8.9
Office equipment (includes computers)	8.7
Mining, crude-oil production	3.7
Soaps, cosmetics	2.1
	DECREASES
Industrial and farm equipment	15.8%
Petroleum refining	9.1
Measuring, scientific, photographic equipment	2.8
Musical instruments, toys, sporting goods	.0
Jewelry, silverware	N.A.
Tobacco	N.A.
Furniture	N.A.
Custom Processors	– 23.1
Proprietary Processors	+ 6.9
All Processors	– 3.8

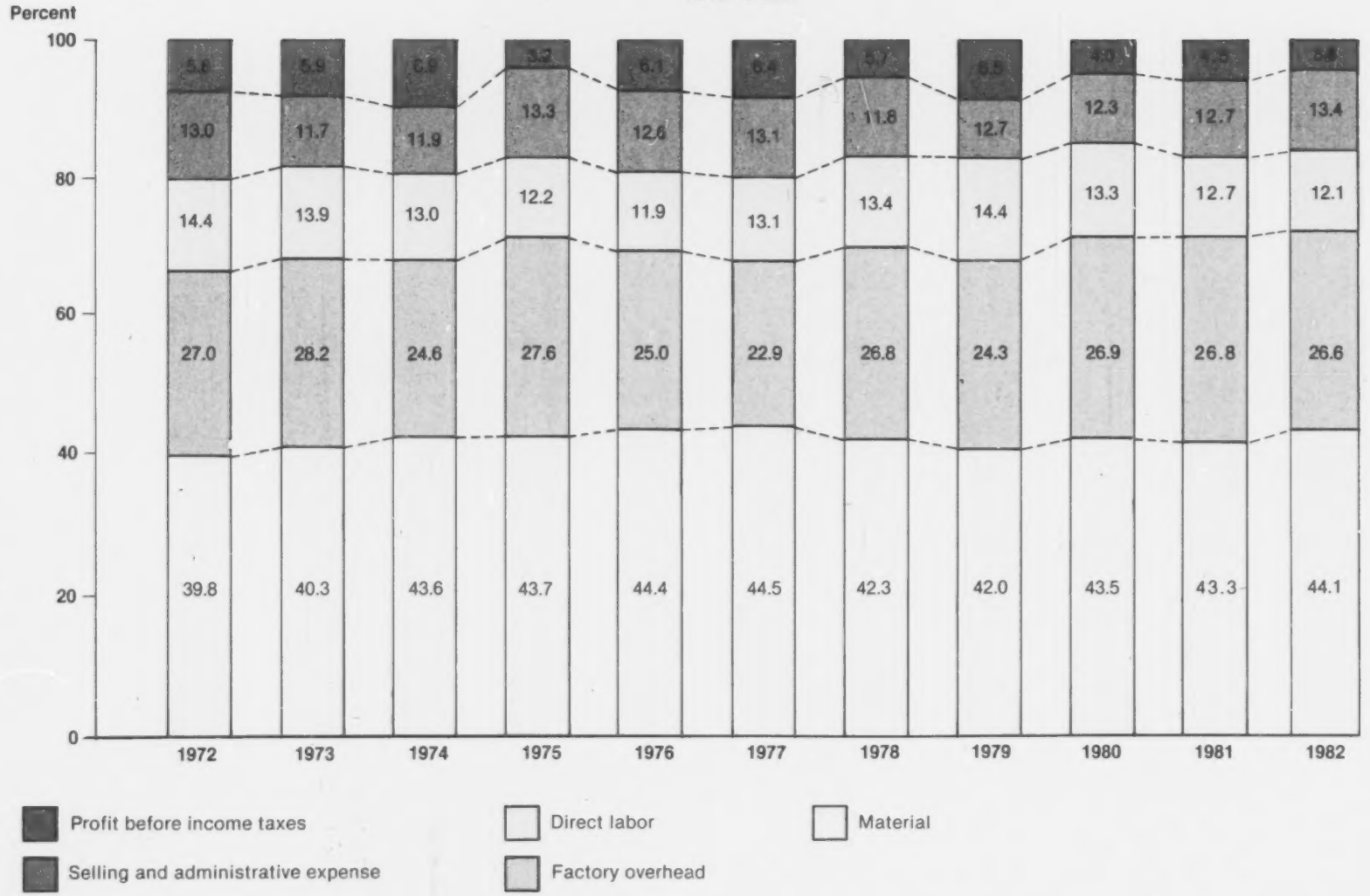
RETURN ON STOCKHOLDERS' EQUITY

THE INDUSTRY MEDIANS

	1983	1982
Publishing, printing	17.8%	15.5%
Pharmaceuticals	17.5	16.9
Beverages	16.9	16.7
Soaps, cosmetics	14.7	16.0
Food	14.5	15.3
Aerospace	13.5	11.7
Apparel	13.0	12.3
Electronics, appliances	12.0	11.6
Shipbuilding, railroad and transportation equipment	11.6	8.6
Office equipment (including computers)	11.1	12.1
Motor vehicles	10.1	5.3
Chemicals	10.0	8.9
Rubber, plastic products	10.0	1.9
Measuring, scientific, photographic equipment	9.9	13.0
Metal products	9.5	12.2
Petroleum refining	9.4	12.5
Mining, crude-oil production	8.9	9.0
Textiles, vinyl flooring	8.7	6.3
Glass, concrete, abrasives, gypsum	8.0	4.3
Paper, fiber, and wood products	7.1	8.0
Industrial and farm equipment	4.7	9.6
Musical instruments, toys, sporting goods	.0	N.A.
Metal manufacturing	.0	.0
Leather	N.A.	N.A.
Furniture	N.A.	N.A.
Tobacco	N.A.	N.A.
Jewelry, silverware	N.A.	N.A.
All Industries	10.6	10.9
Custom Processors	2.8	
Proprietary Processors	8.8	
All Processors	4.7	

Source: "The Fortune Directory of the 500 Largest U.S. Industrial Corporations"
SPI Financial Management Committee, Financial and Operating Ratios Survey

TREND IN DISTRIBUTION OF SALES DOLLAR
PLASTICS PROCESSING COMPANIES
1972-1982



SALES OF MAJOR U.S. PLASTICS PRODUCING COMPANIES

(rounded to nearest $25 million)

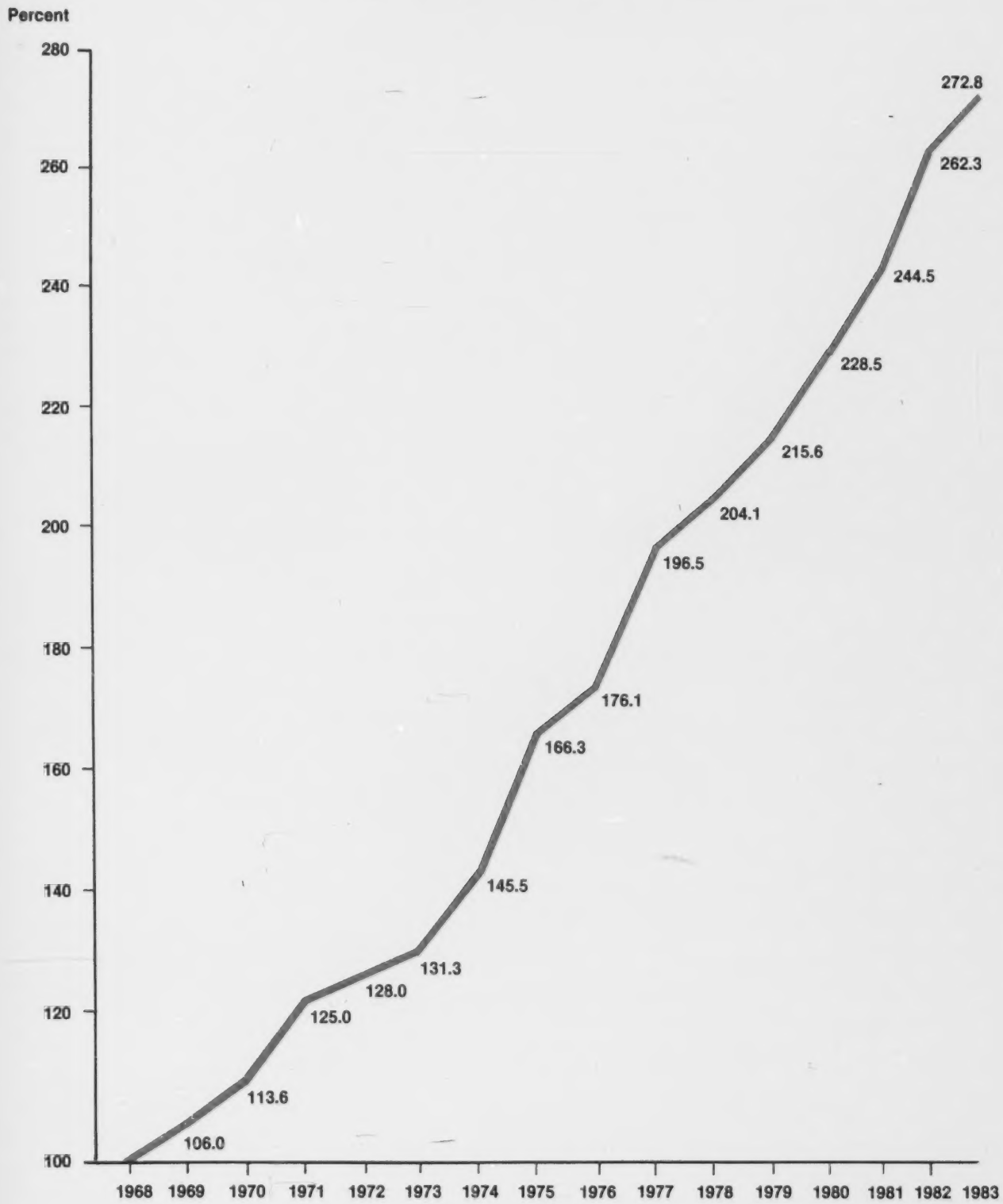
COMPANY[3]	PLASTICS SALES[1]		CHEMICALS SALES[2]		TOTAL SALES	
	1983	1982	1983	1982	1983	1982
1. Du Pont	3,400	3,050	6,925	6,825	35,375	33,325
2. Dow Chemical	3,175	2,250	7,650	7,150	10,950	10,625
3. Exxon	1,700	1,200	7,700	7,250	93,450	102,050
4. Dart & Kraft	1,300	1,400	1,400	1,500	9,725	9,975
5. Union Carbide	1,000	1,050	3,200	3,275	9,000	9,050
6. B.F. Goodrich	925	750	1,125	1,025	3,200	3,000
7. Standard Oil (Indiana)	875	700	3,025	2,925	29,500	29,775
8. Monsanto	800	775	2,675	2,600	6,300	6,325
9. Shell Oil	700	650	3,400	3,225	19,875	20,225
Mobil Oil	700	650	2,425	2,250	59,000	64,100
11. Gulf Oil	675	500	1,775	2,050	28,875	30,625
12. Celanese	650	525	1,550	1,450	3,250	3,050
Hercules	650	700	1,975	2,050	2,625	2,625
14. W.R. Grace	625	600	2,750	2,650	6,225	6,125
15. Phillips Petroleum	575	500	2,250	2,350	15,400	15,900
16. Ethyl	450	400	1,475	1,400	1,750	1,625
Borg Warner	450	350	825	600	3,550	3,200
Georgia Pacific	450	350	800	725	6,475	5,400
19. General Electric	425	400	425	400	26,800	26,500
Occidental Petroleum	425	400	1,450	1,250	19,125	17,725
Reichhold Chemicals	425	375	700	750	750	775
22. Atlantic Richfield	400	425	2,550	2,250	25,925	27,000
Rohm and Haas	400	350	1,800	1,725	1,875	1,825
24. Goodyear Tire & Rubber	300	300	800	800	9,750	9,600
Eastman Kodak	300	250	2,275	2,150	10,175	10,825
Allied	300	275	2,325	2,150	10,025	9,525
27. Tenneco	275	250	1,800	1,700	14,450	14,975
28. Certain Teed	250	200	250	200	1,050	825
National Distillers	250	225	775	675	2,600	1,825
30. U.S. Steel	225	200	1,150	1,100	17,525	18,900
31. Borden	150	125	1,300	1,225	4,275	4,100

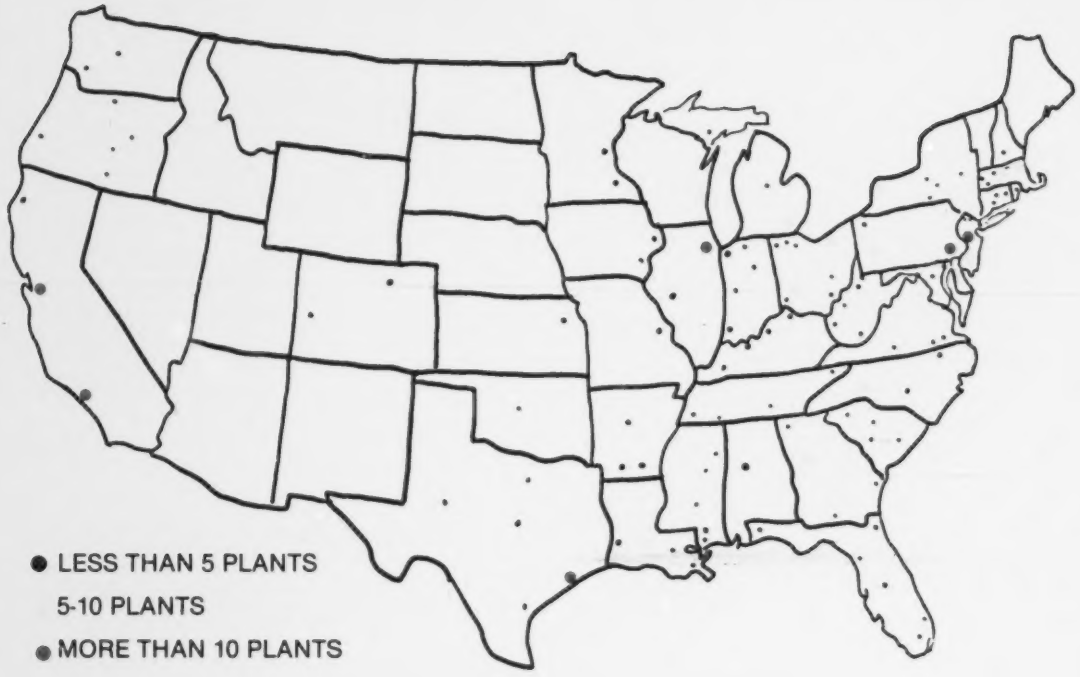
Note: There are several domestic and foreign-based companies which could be listed above had data been available such as Mobay, American Hoechst, Ciba-Geigy, Soltex Polymer, et al.

[1] Includes fabricated plastics products.
[2] Includes plastics.
[3] Ranked by plastics sales in 1982.

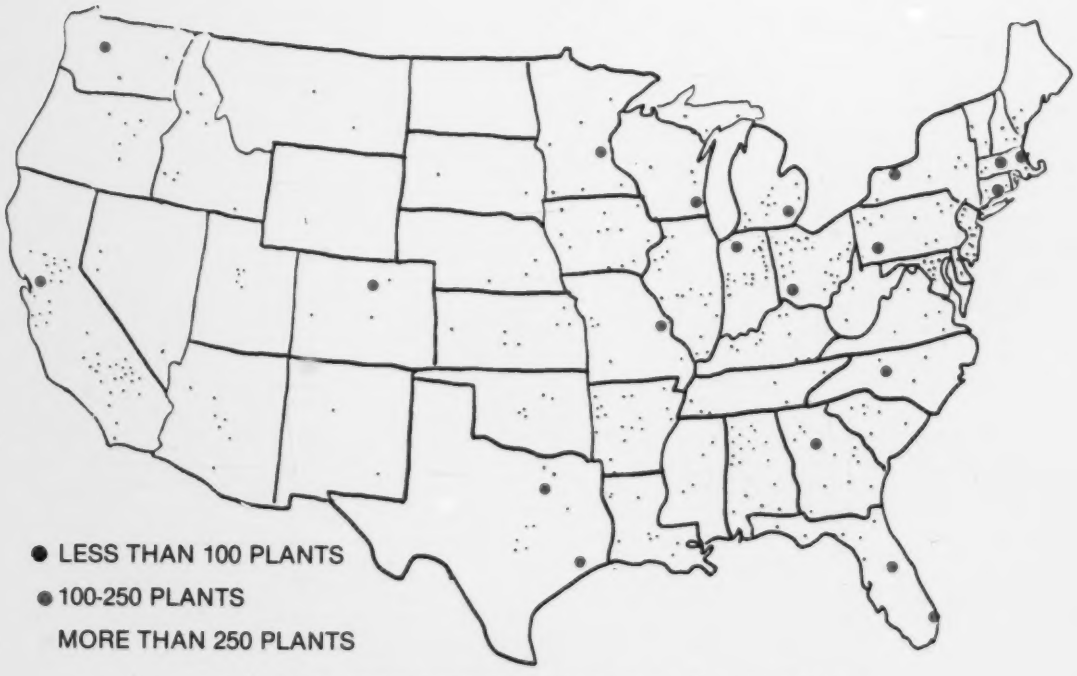
Source: Company annual reports, industry estimates.

PLASTICS PROCESSING COMPANIES
TREND IN STRAIGHT-TIME HOURLY WAGES
1968-1983 (1968 = 100)





U.S. PLASTICS RESIN PLANT LOCATIONS



U.S. PLASTICS PROCESSING PLANT LOCATIONS

TOP 10 STATES OF THE PLASTICS INDUSTRY—1982*

NUMBER OF ESTABLISHMENTS[1]

1. California	2,731
2. New York	1,444
3. Illinois	1,324
4. Ohio	1,233
5. New Jersey	1,209
6. Michigan	1,079
7. Texas	913
8. Pennsylvania	904
9. Massachusetts	837
10. Florida	662

NUMBER OF EMPLOYEES[2]

1. Ohio	86,300
2. California	79,000
3. Illinois	73,000
4. New Jersey	60,100
5. New York	52,100
6. Michigan	51,800
7. Pennsylvania	45,400
8. Massachusetts	40,600
9. Texas	35,700
10. Indiana	34,000

VALUE OF SHIPMENTS[3] ($MILLION)

1. Ohio	$7,902
2. California	6,680
3. Illinois	6,266
4. New Jersey	5,938
5. Texas	5,877
6. Michigan	4,131
7. Pennsylvania	4,079
8. New York	3,917
9. Massachusetts	3,434
10. Indiana	3,039

NEW CAPITAL EXPENDITURES ($ MILLION)

1. Texas	$523
2. Ohio	349
3. Illinois	274
4. California	260
5. Michigan	224
6. New Jersey	190
7. Pennsylvania	149
8. New York	136
9. So. Carolina	135
10. Massachusetts	131

PAYROLL ($ MILLION)

1. Ohio	$1,512
2. California	1,302
3. Illinois	1,233
4. New Jersey	1,043
5. Michigan	951
6. New York	840
7. Pennsylvania	789
8. Massachusetts	680
9. Texas	636
10. Indiana	582

*The plastics industry includes establishments producing resins, machinery, fabricated products, and molds.

[1] A company operating at more than one location is required to file a separate report for each location (establishment)

[2] Includes all employees, administrative and manufacturing.

[3] Covers the received or receivable net selling values, f.o.b. plant (exclusive of freight and taxes), of all products shipped, both primary and secondary, as well as all miscellaneous receipts, such as receipts for contract work performed for others, installation and repair, sales of scrap, and sale of products bought and resold without further processing.

Source: Dept. of Commerce, Bureau of the Census
SPI estimates

PLASTIC PROCESSING INDUSTRY BY SALES GROUP-1982

Operating Statements	SALES LESS THAN $5 MILLION		
	Less Profitable	Median	More Profitable
Sales	100.0	100.0	100.0
Less Adjustments & Allowances	0.9	0.9	1.0
Net Sales	99.1	99.1	99.0
Direct Materials	40.5	39.6	38.2
Direct Labor	11.9	12.6	13.4
Indirect Labor	7.1	7.2	7.2
Utilities	4.7	3.2	2.8
Depreciation	4.1	3.3	2.7
Other Mfg. Expense	11.2	10.8	10.1
Net on Tool Transactions	0.2	0.3	0.4
Selling Expenses	6.1	5.3	4.4
Administrative Expense	11.4	11.1	10.3
Operating Earnings	2.6	5.7	8.8
Misc. (Income) or Expense	1.0	1.0	0.6
Profit Before Income Taxes	1.6	4.7	8.2
Income Taxes	0.0	1.6	2.9
PROFIT AFTER INCOME TAXES	1.0	3.7	5.3
Sales as Percentage of Total Assets	190.1%	193.3%	196.5%
Balance Sheets			
Cash	2.9	4.5	6.1
Accounts & Notes Receivable	30.3	32.3	34.2
Inventory	20.9	23.2	25.6
Other Current Assets	2.0	1.8	1.6
CURRENT ASSETS	56.1	61.8	67.5
Land & Buildings, at Cost	13.7	10.3	7.0
Depreciation Reserve	1.7	2.6	3.5
Machinery & Equipment, at Cost	62.4	59.5	56.5
Depreciation Reserve	34.9	32.3	29.7
Other Long-Term Assets	4.4	3.3	2.2
TOTAL ASSETS	100.0	100.0	100.0
Current Portion of Term Debt	5.4	3.9	2.5
Notes Payable	28.8	17.3	5.7
Accounts Payable, Trade	17.2	17.6	18.0
Other Payables & Accruals	7.3	7.9	8.5
CURRENT LIABILITIES	58.7	46.7	34.7
Other Long-Term Debt	1.2	1.3	1.3
TOTAL LIABILITIES	59.9	48.0	36.0
EQUITY (NET WORTH)	40.1	52.0	64.0
Statistical Data			
Percent Change in Sales, '83 vs. '82	12.1%	12.3%	12.4%
365 ÷ (Cost of Sales/Inventory)	50.3†	56.5†	63.1†
Average Collection Period	58.2	61.0	63.5
Profit Before Income Taxes/Assets	3.0%	9.1%	16.1%
Net Income/Equity	4.7%	13.8%	16.3%

†Days
Less Profitable: PBIT less than 4.7%
More Profitable: PBIT equal to or more than 4.7%

Source: SPI Financial and Operating Ratios Survey No. 22—1983

PLASTIC PROCESSING INDUSTRY BY SALES GROUP-1982

Operating Statements	SALES $5-$10 MILLION		
	Less Profitable	Median	More Profitable
Sales	100.0	100.0	100.0
Less Adjustments & Allowances	2.0	1.5	1.0
Net Sales	98.0	98.5	99.0
Direct Materials	46.7	46.2	44.5
Direct Labor	11.7	10.7	9.4
Indirect Labor	5.2	6.9	9.7
Utilities	3.2	3.0	2.8
Depreciation	2.7	2.5	2.3
Other Mfg. Expense	10.5	10.7	10.8
Net on Tool Transactions	0.9	0.4	(0.1)
Selling Expenses	6.9	6.4	4.8
Administrative Expense	8.8	8.0	7.2
Operating Earnings	1.9	3.7	8.2
Misc. (Income) or Expense	0.2	0.1	(0.2)
Profit Before Income Taxes	1.5	3.6	8.0
Income Taxes	0.4	1.1	3.5
PROFIT AFTER INCOME TAXES	1.1	2.5	4.5
Sales as Percentage of Total Assets	170.9%	170.9%	168.7%
Balance Sheets			
Cash	1.8	4.6	7.3
Accounts & Notes Receivable	26.7	26.9	27.0
Inventory	21.5	19.7	18.0
Other Current Assets	1.6	1.6	1.8
CURRENT ASSETS			
Land & Buildings, at Cost	21.1	24.0	24.6
Depreciation Reserve	7.4	7.0	6.5
Machinery & Equipment, at Cost	56.2	57.0	58.9
Depreciation Reserve	35.5	35.0	33.5
Other Long-Term Assets	14.0	8.2	2.4
TOTAL ASSETS	100.0	100.0	100.0
Current Portion of Term Debt	4.9	3.8	2.8
Notes Payable	13.6	13.4	13.2
Accounts Payable, Trade	13.4	13.1	12.8
Other Payables & Accruals	9.0	8.8	8.6
CURRENT LIABILITIES	40.9	39.1	36.4
Other Long-Term Debt	6.8	5.4	4.1
TOTAL LIABILITIES	47.7	44.5	40.5
EQUITY (NET WORTH)	52.3	55.5	59.5
Statistical Data			
Percent Change in Sales, '83 vs. '82	0.1%	5.6%	11.0%
365 ÷ (Cost of Sales/Inventory)	56.2†	51.6†	48.7†
Average Collection Period	57.0	57.5	58.4
Profit Before Income Taxes/Assets	2.6%	6.2%	13.5%
Net Income/Equity	3.6%	7.7%	12.8%

Less Profitable: PBIT less than 3.6%
More Profitable: PBIT equal to or more than 3.6%

Source: SPI Financial and Operating Ratios Survey No. 22—1983

PLASTIC PROCESSING INDUSTRY BY SALES GROUP-1982

Operating Statements	SALES $10 MILLION AND OVER		
	Less Profitable	Median	More Profitable
Sales	100.0	100.0	100.0
Less Adjustments & Allowances	0.8	1.5	2.2
Net Sales	99.2	98.5	97.8
Direct Materials	46.1	44.0	42.0
Direct Labor	11.3	10.8	10.3
Indirect Labor	11.2	10.4	9.5
Utilities	3.3	3.5	3.7
Depreciation	3.0	2.9	2.7
Other Mfg. Expense	7.1	6.5	6.0
Net on Tool Transactions	(0.4)	0.3	0.1
Selling Expenses	4.8	4.6	4.3
Administrative Expense	7.1	7.6	8.2
Operating Earnings	5.7	7.9	11.0
Misc. (Income) or Expense	2.1	1.2	(0.2)
Profit Before Income Taxes	3.6	6.7	11.2
Income Taxes	1.5	2.5	4.3
PROFIT AFTER INCOME TAXES	2.1	4.2	6.9
Sales as Percentage of Total Assets	172.8%	183.0%	193.1%
Balance Sheets			
Cash	1.2	2.4	3.6
Accounts & Notes Receivable	24.3	26.8	29.3
Inventory	15.4	16.9	18.5
Other Current Assets	2.6	2.2	1.7
CURRENT ASSETS	43.5	48.3	53.1
Land & Buildings, at Cost	34.2	29.3	24.3
Depreciation Reserve	9.7	7.3	4.9
Machinery & Equipment, at Cost	55.7	55.1	54.5
Depreciation Reserve	29.6	29.9	30.1
Other Long-Term Assets	5.9	4.5	3.1
TOTAL ASSETS	100.0	100.0	100.0
Current Portion of Term Debt	3.1	1.7	0.3
Notes Payable	5.6	3.7	1.7
Accounts Payable, Trade	10.4	9.9	9.5
Other Payables & Accruals	8.3	10.2	12.1
CURRENT LIABILITIES	27.4	25.5	23.6
Other Long-Term Debt	26.7	20.2	13.4
TOTAL LIABILITIES	54.1	45.7	37.0
EQUITY (NET WORTH)	45.9	54.3	63.0
Statistical Data			
Percent Change in Sales, '83 vs. '82	1.6%	13.7%	25.7%
365 ÷ (Cost of Sales/Inventory)	40.8†	42.3†	45.8†
Average Collection Period	51.3	53.5	55.4
Profit Before Income Taxes/Assets	6.2%	12.3%	21.6%
Net Income/Equity	7.9%	14.2%	21.1%

†Days
Less Profitable: PBIT less than 6.7%
More Profitable: PBIT equal to or more than 6.7%

Source: SPI Financial and Operating Ratios Survey No. 22—1983

FEEDSTOCKS & ADDITIVES

PLASTICS DERIVED FROM MAJOR FEEDSTOCKS*

(in millions of pounds)

FEEDSTOCK	Total Production		Plastics Derivatives		Plastics % of Total	
	1983	1982	1983	1982	1983	1982
Ethylene	28,600	24,700	19,455	17,415	68	71
Propylene	12,600	12,300	6,760	5,350	54	43
Benzene	9,425	7,850	6,615	5,575	70	71

*These data should not be construed to represent the entire feedstock needs of the U.S. plastics industry. They are based on 1982 and 1983 plastics production only and do not include feedstock needs for monomers, additives, and other chemicals not used in domestic production.

PLASTICS CONSUMPTION OF FEEDSTOCKS—1983

(millions of pounds)

Ethylene	Styrene Butadiene Latex	175	0.9%
	Styrene Acrylonitrile	25	0.2
	Acrylonitrile Butadiene Styrene	175	0.9
	Polyvinyl acetate	275	1.4
	Polyethylene	14,420	74.1
	Polystyrene	1,200	6.2
	Other Styrenes	45	0.2
	Polyvinyl chloride	3,140	16.1
		19,455	100.0%
Propylene	Epoxy	130	1.9%
	Phenolic	1,180	17.5
	Polypropylene	4,875	72.1
	Polyester	235	3.5
	Styrene Acrylonitrile	40	0.6
	Acrylonitrile Butadiene Styrene	300	4.4
		6,760	100.0%
Benzene	Acrylonitrile Butadiene Styrene	470	7.1%
	Styrene Acrylonitrile	60	1.0
	Styrene Butadiene Latex	400	6.0
	Polystyrene	3,250	49.1
	Other Styrene	100	1.5
	Epoxy	225	3.4
	Polyester	245	3.7
	Nylon	460	7.0
	Phenolic	1,405	21.2
		6,615	100.0%

SELECTED PLASTICS PRECURSORS

PRECURSOR	Total Production		*Plastics Derivatives		Plastics % of Total	
	1983	1982	1983	1982	1983	1982
Acrylonitrile	2,145	2,040	230	180	11	9
Bisphenol A	645	480	550	430	85	90
Butadiene	2,315	1,825	500	360	22	20
Cyclohexane	1,690	1,275	365	260	22	20
Formaldehyde	5,400	4,700	4,470	3,800	83	81
Maleic Anhydride	300	260	175	140	58	54
Phenol	2,610	2,140	2,100	1,650	80	77
Phthalic Anhydride	850	700	495	420	58	60
Styrene	6,985	5,925	5,175	4,410	74	74
Vinyl Acetate	1,960	1,875	1,960	1,875	100	100
Vinyl Chloride	6,950	6,500	6,950	6,500	100	100

Source: U.S. International Trade Commission, SRI International, Society of the Plastics Industry estimates

ADDITIVES FOR PLASTICS

ADDITIVE LUBRICANTS

These materials are added to plastics to assist flow in calendering, molding and extrusion by lubricating the metal surfaces in contact with the plastic. They also assist in knitting and wetting of the resin in mixing and milling operations. To be effective, lubricants must be compatible with the resins in which they are used, must not adversely affect the properties of end-products, and must be easily combined.

Examples: stearic acid, waxes, fatty acid esters, fatty acid amines.

ANTIOXIDANTS

They inhibit the oxidation of materials exposed to air or oxygen at normal or elevated temperatures. They are used in plastics which are subject to oxidative degradation, such as polyolefins, ABS, polystyrene, acetal and polyphenylene oxide.

Examples: alkylated phenols, amines, organic phosphites and phosphates, esters.

ANTISTATS

Chemicals which impart a slight to moderate degree of electrical conductivity to plastics compounds, thus preventing the accumulation of electrostatic charges on finished articles. They may be incorporated in the materials before molding, or applied to their surfaces after molding. They function either by being inherently conductive or by absorbing moisture from the air.

Examples: quaternary ammonium compounds, anionics, amines.

BLOWING AGENTS [FOAMING AGENTS]

Substances which alone or in combination with other substances are capable of producing a cellular structure in a plastic or rubber mass. Thus, the term includes compressed gases which expand when pressure is released, soluble solids that leave pores when leached out, liquids that develop cells when they change to gases, and chemical agents that decompose or react under the influence of heat to form a gas.

Examples: azodicarbonamide, modified azos, OBSH, HTBA.

COLORANTS

Dyes or pigments which impart color to plastics. The dyes are synthetic or natural compounds of submicroscopic or molecular size, soluble in most common solvents, yielding perfectly transparent colors. The pigments are organic and inorganic substances with larger particle sizes and usually insoluble in the common solvents. Colorants are added to plastics by dry coloring (tumbling the colorant with the base or compounded resin); by extrusion coloring (extruding a dry colored mixture and chopping it into pellets to be reprocessed); by masterbatching; or by stirring colorants or dispersions thereof into liquid plastisols or resin systems.

Examples: titanium dioxide, iron oxides, anthraquinones, carbon black.

FLAME RETARDANTS

Materials that reduce the tendency of plastic articles to burn. They are usually incorporated as additives during compounding, but sometimes are applied to surfaces of finished articles.

Examples: antimony trioxide, chlorinated paraffins, bromophenols.

HEAT STABILIZERS

Agents used in compounding some plastics to assist in maintaining the physical and chemical properties of the compounded materials at suitable values throughout the processing and service life of the material and/or the parts made therefrom. They protect plastics from the effects of heat such as changes in color, decrease in mechanical and electrical properties, and undesirable surface conditions.

Examples: lead, barium-cadmium, tin, calcium-zinc.

ORGANIC PEROXIDES

Thermally decomposable compounds which can initiate polymerization reactions and effect cross-linking upon decomposition. The rate of decomposition can be controlled by means of promoters or accelerators added to the system to increase the decomposition rate; or by inhibitors when it is desired to retard the decomposition.

Examples: MEK peroxide, benzoyl peroxide, alkyl peroxide, peresters.

PLASTICIZERS

Materials incorporated in a plastic or elastomer to increase its flexibility, workability or distensibility. Most plasticizers are nonvolatile organic liquids or low-melting point solids, which function by reducing the normal intermolecular forces in a resin thus permitting the macromolecules to slide over one another more freely.

Examples: adipates, azelates, trimellitates, DOP/DIOP/DIDP.

ULTRAVIOLET STABILIZERS (UV LIGHT ABSORBERS)

Chemical agents which absorb or screen out radiation beyond the violet end of the spectrum of visible radiations. Such radiation has sufficient energy to initiate reactions leading to the degradation of many plastics. These agents are often combined with other additives, e.g. heat stabilizers and antioxidants, with which they act in synergistic fashion.

Examples: benzophenones, benzotriazole, salicylates.

Source: Whittington's Dictionary of Plastics

CONSUMPTION OF ADDITIVES

(millions of pounds)

TYPE	1979	1980	1981	1982	1983
Additive Lubricants	104	77	88	83	85
Antioxidants	36	32	34	31	34
Antistats	5	5	6	6	6
Blowing Agents	16	10	11	11	11
Colorants	342	307	331	320r	353
Flame Retardants	451	475	420	378r	422
Heat Stabilizers	92	83	86	78	81
Organic Peroxides	39	34	37	33	35
Plasticizers	1,654	1,485	1,505	1,327r	1,390
Ultraviolet Stabilizers	5	5	5	5	5

Source: Modern Plastics Magazine
r = revised from 1983 edition

DEFINITIONS OF PLASTICS

ACETAL

An engineering thermoplastic produced by the polymerization of purified formaldehyde [CH_2O] into both homopolymer and copolymer types. Typical applications are found in consumer products, automotive parts, and industrial machinery parts.

ACRYLICS

A family of thermoplastic resins of acrylic esters [$CH_2CHCOOR$] or methacrylic esters [$CH_2C(CH_3)COOR$]. The acrylates may be methyl, ethyl, butyl, or 2-ethylhexyl. Usual methacrylates are the methyl, ethyl, butyl, laural and stearyl. Typical applications are found in lighting fixtures, glazing and automotive parts.

ACRYLONITRILE BUTADIENE STYRENE

A class of thermoplastic terpolymers including a range of resins, all prepared with usually more than 50% styrene [$C_6H_5CHCH_2$] and varying amounts of acrylonitrile [CH_2CHCN] and butadiene [$CH_2CHCHCH_2$]. The three components are combined by a variety of methods involving polymerization, graft copolymerization, physical mixtures and combinations thereof. Typical applications are found in appliances, automotive parts, pipe, and business machine and telephone components.

ALKYDS

Thermosetting unsaturated polyester resins produced by reacting an organic alcohol with an organic acid, dissolved in and reacted with unsaturated monomers such as styrene [$C_6H_5CHCH_2$], diallyl phthalate [$C_6H_4(COOCH_2CHCH_2)_2$], diacetone acrylamide [$CH_3COCH_2C(CH_3)_2CHCHCONH_2$] or vinyl toluene [$CH_2CHC_6H_4CH_2$]. Typical applications are found in electrical uses, automotive parts, and as coatings.

CELLULOSICS

A family of thermoplastic resins manufactured by chemical modification of cellulose [$(C_6H_{10}0_5)_n$]. Included are: *cellophane*—regenerated cellulose made by mixing cellulose xanthate [ROCSSH] with a dilute sodium hydroxide [NaOH] solution to form a viscose, then extruding the viscose into an acid bath for regeneration; *cellulose acetate*—an acetic acid ester [$CH_3COOC_2H_5$] of cellulose; *cellulose acetate butyrate*—a mixed ester produced by treating fibrous cellulose with butyric acid [$CH_3CH_2CH_2COOH$], butyric anhydride [$(CH_3CH_2CH_2CO)_2O$], acetic acid [CH_3COOH] and acetic anhydride [$(CH_3CO)_2O$] in the presence of sulfuric acid [H_2SO_4]; *cellulose propionate*—formed by treating fibrous cellulose with propionic acid [$CH_3CH_2CO_2H$] and acetic acid and anhydrides in the presence of sulfuric acid; *cellulose nitrate*—made by treating fibrous cellulosic materials with a mixture of nitric [HNO_3] and sulfuric acids. Typical applications of cellulosics are found in packaging, consumer products, and automotive parts.

COUMARONE-INDENE

Thermoplastic resin obtained by heating mixtures of coumarone [C_8H_6O] and indene [$C_6H_4CH_2CHCH$] with sulfuric acid (H_2SO_4] to promote polymerization. These resins have no commercial applications when used alone. They are used primarily as processing aids, extenders and plasticizers with other resins in asphalt floor tile.

DIALLYL PHTHALATE(DAP)

The term DAP is used both for the monomeric and polymeric forms. The monomer [$C_6H_4(COOCH_2CHCH_2)_2$] is used as a cross-linking agent in unsaturated polyester resins. As a polymer, it is used in the production of thermosetting molding powders, casting resins and laminates.

EPOXY

Thermosetting resins, that, in the uncured form, contain one or more reactive epoxide or oxirane groups These epoxide groups serve as cross-linking points in the subsequent curing step, in which the uncured epoxy is reacted with a curing agent or hardener. Cross-linking is accomplished through the epoxide groups as well as through hydroxyl groups that may be present. Most conventional unmodified epoxy resins are produced from epichlorohydrin (chloropropylene oxide) [CH_2OCHCH_2Cl] and bisphenol A [$(CH_3)_2C(C_6H_4OH)_2$]. The other types of epoxy resins are phenoxy resins, novolac resins, and cycloaliphatic resins. Epoxy resins are used as protective coatings, bonding adhesives, in building and construction, and electrical uses, plus many other uses.

FLUOROPOLYMERS

A family of thermoplastic resins analogous to polyethylene in which some of the hydrogen atoms attached to the carbon chain are replaced by fluorine or fluorinated alkyl groups. In some cases, other halogens such as chlorine are also part of the molecule. The most common commercial fluoropolymers are: *FEP* (fluorinated ethylene-propylene) from tetrafluoroethylene [C_2F_4] and hexafluoropropylene [C_3F_6]; *PTFE* (polytetrafluoroethylene) from the polymerization of tetrafluoroethylene and ethylene [C_2H_4]; *PFA* (perfluoroalkoxy) from tetrafluoroethylene and perfluoropropyl vinyl ether [$C_3H_7C_4OF_5$]; *PCTFE* (polychlorotrifluoro-ethylene) from chlorotrifluoro-ethylene monomer [C_2F_3Cl]; *CTFE-VDF* (polychlorotrifluoroethylenevinylidene fluoride) from chlorotrifluoroethylene and vinylidene fluoride [$C_2H_2F_2$]; *E-CTFE* (polyethylene-chlorotrifluoroethylene) from chlorotrifluoroethylene and ethylene; *PVDF* (polyvinylidene fluoride) from vinylidene fluoride monomer; and, *PVF* (polyvinyl fluoride) from vinyl fluoride monomer [C_2H_3F]. Typical applications for fluoropolymers are found in electrical/electronic uses and pipe and chemical processing equipment.

MELAMINE-FORMALDEHYDE

Thermosetting resins formed by the condensation reaction of formaldehyde [HCHO] and melamine [$C_3N_3(NH_2)_3$]. The chemistry is analogous to that of urea-formaldehyde except that the three amino groups of melamine provide more possibilities for cross-linking, are more highly reactive, and all six hydrogen atoms of melamine will react, forming the hexamethyl compound. Typical applications are found in bonding and adhesives, coatings, and consumer products.

NITRILE RESINS

Thermoplastic resins composed of acrylonitrile [CH_2CHCN], along with co-monomers such as acrylates, methacrylates, butadiene [$CH_2CHCHCH_2$] and styrene [$C_6H_5CHCH_2$]. Both straight copolymers and copolymers grafted onto elastomeric backbones are available. The unique property of these materials is outstanding resistance to passage of gases and water vapor, making them useful in packaging applications.

NYLON

A generic name for a family of long-chain polyamide engineering thermoplastics which have recurring amide groups [-CO-NH-] as an integral part of the main polymer chain. Nylons are synthesized from intermediates such as dicarboxylic acids, diamines, amino acids and lactams, and are identified by numbers denoting the number of carbon atoms in the polymer chain derived from specific constituents, those from the diamine being given first. The second number, if used, denotes the number of carbon atoms derived from a diacid. Commercial nylons are as follows: *nylon 4* (polypyrrolidone)—a polymer of 2-pyrrolidone [$CH_2CH_2CH_2C(O)NH$]; *nylon 6* (polycaprolactam)—made by the polycondensation of caprolactam [$CH_2(CH_2)_4NHCO$]; *nylon 6/6*—made by condensing hexamethylenediamine [$H_2N(CH_2)_6NH_2$] with adipic acid [$COOH(CH_2)_4COOH$]; *nylon 6/10*—made by condensing hexamethylenediamine with sebacic acid [$COOH(CH_2)_8COOH$]; *nylon 6/12*—made from hexamethylenediamine and a 12-carbon dibasic acid; *nylon 11*—produced by polycondensation of the monomer 11-amino-undecanoic acid [$NH_2CH_2(CH_2)_9COOH$]; *nylon 12*—made by the polymerization of laurolactam [$CH_2(CH_2)_{10}CO$] or cyclododecalactam, with 11 methylene units between the linking -NH-CO- groups in the polymer chain. Typical applications for nylons are found in automotive parts, electrical/electronic uses, and packaging.

PETROLEUM RESINS

Thermoplastic resins obtained from a variable mixture of unsaturated monomers recovered as a by-product from cracked and distilled petroleum streams. They also contain indene [$C_6H_4CH_2CHCH$], which is copolymerized with a variety of other monomers including styrene [$C_6H_5CHCH_2$], vinyl toluene [$CH_2CHC_6H_4CH_3$], and methyl indene [$C_6H_3CH_3CH_2CHCH$]. Typical applications are found in adhesives, printing inks, rubber compounding, and surface coatings.

PHENOLIC

These thermosetting resins are credited with being the first commercialized wholly synthetic polymer or plastic. The basic raw materials are formaldehyde [HCHO] and phenol [C_6H_5OH], although almost any reactive phenol or aldehyde can be used. The phenols used commercially are phenol, cresols [$CH_3C_6H_4OH$], xylenols [$(CH_3)_2C_6H_3OH$], p-t-butylphenol [$C_4H_9C_6H_4OH$], p-phenylphenol [$C_6H_5C_6H_4OH$], bisphenols [$(C_6H_4OH)_2$], and resorcinol [$C_6H_4(OH)_2$]. The aldehydes used are formaldehyde and furfural [C_4H_3OCHO]. In the uncured and semi-cured condition, phenolic resins are used as adhesives, casting resins, potting compounds, and laminating resins. As molding powders, phenolic resins can be found in electrical uses.

POLYAMIDE-IMIDE

Engineering thermoplastic resins produced by the condensation reaction of trimellitic anhydride [$OCC_6H_2C_2O_3$] and various aromatic diamines. Typical applications are found in aerospace, automotive and heavy equipment industries.

POLYARYLATES

Engineering thermoplastic resins produced by interfacial polymerization of an aqueous solution of the disodium salt of bisphenol A [$(CH_3)_2C(C_6H_4OH)_2$] with phthalic acid chlorides [$C_6H_4(CO)_2Cl_2$] in methylene chloride (CH_2Cl_2]. The major use of polyarylates is in outdoor lighting.

POLYBUTYLENE

Thermoplastic resins produced via stereospecific Ziegler-Natta polymerization of butene-1 monomer [$CH_2CHCH_2CH_3$]. Typical applications are found in pipe and packaging film.

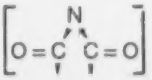
POLYCARBONATE

Engineering thermoplastic resins produced by (1) phosgenation of dihydric phenols, usually bisphenol A [$(CH_3)_2C(C_6H_4OH)_2$], (2) ester exchange between diaryl carbonates and dihydric phenols, usually between diphenyl carbonate [$(C_6H_5O)_2CO$] and bisphenol A and (3) interfacial polycondensation of bisphenol A and phosgene [$COCl_2$]. Typical applications are found in glazing, appliances, and electrical uses.

POLYETHYLENE

A family of thermoplastic resins obtained by polymerizing the gas ethylene [C_2H_4]. Low molecular weight polymers of ethylene are fluids used as lubricants; medium weight polymers are waxes miscible with paraffin; and the high molecular weight polymers (i.e. over 6000) are the materials used in the plastics industry. Polymers with densities ranging from about .910 to .925 are called *low density;* those of densities from .926 to .940 are called *medium density;* and those from .941 to .965 and over are called *high density.* The low density types are polymerized at very high pressures and temperatures, and the high density types at relatively low temperatures and pressures. A relatively new type called linear low density polyethylene is manufactured through a variety of processes: gas phase, solution, slurry, or high pressure conversion. A high efficiency catalyst system aids in the polymerization of ethylene at lower temperatures and pressures than required in conventional low density polyethylene. Copolymers of ethylene with vinyl acetate ethyl acrylate, and acrylic acid are commercially important. Major polyethylene applications can be found in packaging, housewares, toys, and communications equipment.

POLYIMIDES

A family of thermoset and thermoplastic resins characterized by repeating imide linkages 

There are four types of aromatic polyimides: (1) condensation products made by the reaction of pyromellitic dianhydride (PMDA) [$C_6H_2(C_2O_3)_2$] and aromatic diamines such as 4,4'-diaminodiphenyl ether [$(C_6H_4NH_2)_2O$]; (2) condensation products of 3,4,3',4'-benzophenone tetracarboxylic dianhydride (BTDA) [$(C_6H_5)_2CO(C_2O_3)_2$] and aromatic amines; (3) the reaction of BTDA and a diisocyanate such as 4,4'-methylene-bis(phenylisocyanate) [$OCNC_6H_4CH_2C_6H_4NCO$]; and, (4) a polyimide based on diaminophenylindane and a dicarboxylic anhydride such as carbonyldiphthalic anhydride [$OC_6H_4(CO)_2COC_6H_4(CO)_2O$]. Thermoset polyimides are produced in condensation polymers that possess reactive terminal groups capable of subsequent cross-linking through an addition reaction. Typical applications for thermoplastic and thermosetting polyimides are in transportation and electronics.

POLYPHENYLENE OXIDE, MODIFIED

Engineering thermoplastic resins produced by the oxidative coupling of 2, 6-dimethylphenol [$(CH_3)_2C_6H_3OH$] (xylenol), then blended with impact polystyrene. Typical applications are found in electrical/electronic uses, business machine parts, appliances, and automotive parts.

POLYPHENYLENE SULFIDE

Engineering thermoplastic resins produced by the reaction of p-dichlorobenzene [$C_6H_4Cl_2$] with sodium sulfide [Na_2S]. The major use for polyphenylene sulfide is in electrical/electronic parts and automotive parts.

POLYPROPYLENE

Thermoplastic resins made by polymerizing propylene [CH_3CHCH_2] and in the case of copolymers with monomers, with suitable catalysts, generally aluminum alkyl and titanium tetrachloride mixed with solvents. The monomer unit in polypropylene is asymmetric and can assume two regular geometric arrangements: isotactic, with all methyl groups aligned on the same side of the chain, or syndiotactic, with the methyl groups alternating. All other forms, where this positioning is random, are called atactic. Commercial polypropylene contains 90-97% crystalline or isotactic PP with the remainder being atactic. Most processes remove excess atactic PP. This by-product is used in adhesives, caulks, and cable-filling compounds. Major applications of commercial PP are found in packaging, automotive, appliance and carpeting markets.

POLYSTYRENE

High molecular weight thermoplastic resins produced generally by the free-radical polymerization of styrene monomer [$C_6H_5CHCH_2$] which can be initiated by heating alone but more effectively by heating in the presence of a free-radical initiator (such as benzoyl peroxide [$(C_6H_5CO)_2O_2$]). Typical processing techniques are modified mass polymerization or solution polymerization, suspension polymerization, and expandable beads. Major markets for polystyrene are in consumer and institutional products, electrical/electronic uses, and building/construction.

POLYURETHANES

A large family of polymers based on the reaction product of an organic isocyanate with compounds containing a hydroxyl group. The commonly used isocyanates are toluene diisocyanate (TDI) [$CH_3C_6H_3(NCO)_2$], methylene diphenyl isocyanate (MDI) [$OCNC_6H_4CH_2C_6H_4NCO$], and polymeric isocyanates (PMDI), obtained by the phosgenation of polyamines derived from the condensation of aniline [$C_6H_5NH_2$] with formaldehyde [HCHO]. Polyols (with hydroxyl groups) are macroglycols which are either polyester or polyether based. Polyurethane elastomers and resins take the form of liquid casting systems, thermoplastic elastomers and resins, microcellular products, and millible gums. Typical applications are found in the automotive industry. Polyurethane foams are widely used in transportation, furniture, and construction markets.

POLYVINYL ACETATE (PVAc) & OTHER VINYLS

Polyvinyl acetate is a thermoplastic resin produced by the polymerization of vinyl acetate monomer [$CH_3COOCHCH_2$] in water producing an emulsion with a solids content of 50-55%. Most polyvinyl acetate emulsions contain co-monomers such as n-butyl acrylate, 2-ethyl hexyl acrylate, ethylene, dibutyl maleate and dibutyl fumarate. Polymerization of vinyl acetate with ethylene also can be used to produce solid vinyl acetate/ethylene copolymers with more than 50% vinyl acetate content. Polyvinyl alcohol (PVOH) is produced by methanolysis or hydrolysis of polyvinyl acetates. The reaction can be controlled to produce any degree of replacement of acetate groups. Co-polymers of replaced acetate groupings and other monomers such as ethylene and acrylate esters are commercially important. *Polyvinyl butyral* (PVB)—made by reacting PVOH with butyraldehyde [$CH_3(CH_2)_2CHO$]. *Polyvinyl formal*—made by condensing formaldehyde [HCHO] in the presence of PVOH or by the simultaneous hydrolysis and acetylization of PVAc. *Polyvinylidene chloride*—made by the polymerization of 1,1-dichloroethylene [CH_2CCl_2]. Typical applications for the above resins are found in adhesives, paints, coatings and finishes, and packaging.

POLYVINYL CHLORIDE

Thermoplastic resins produced by the polymerization of the gas vinyl chloride [CH_2CHCl]. Under pressure, vinyl chloride becomes liquified and is polymerized by one of four basic processes: suspension, emulsion, bulk, and solution polymerization. The pure polymer is hard, brittle and difficult to process, but it becomes flexible when plasticizers are added. A special class of PVC resin of fine particle size, often called dispersion grade resin, can be dispersed in liquid plasticizers to form plastisols. The addition of a volatile diluent or a solvent to the plastisol produces an organosol. Copolymers with vinyl acetate, vinylidene chloride, and maleate and fumarate esters find commercial application. Major markets for PVC are in building/construction, packaging, consumer and institutional products, and electrical/electronic uses.

STYRENE ACRYLONITRILE

Thermoplastic copolymers of styrene [$C_6H_5CHCH_2$] and acrylonitrile [CH_2CHCN]. SAN resins are random, amorphous copolymers produced by emulsion, suspension, or continuous mass polymerization. Typical uses include automobile instrument lenses and housewares.

STYRENE BUTADIENE LATEXES & OTHER STYRENE COPOLYMERS

Styrene butadiene latexes usually have a resin content of about 50%. The styrene/butadiene ratio varies from 54:46 to 80:20. Most are carboxylated by the use of such acids as maleic [HOOCCHCHCOOH], fumaric [HOOCCHCHCOOH], acrylic [$CH_2CHCOOH$], or methacrylic [$CH_2C(CH_3)COOH$]. Two types of *styrene-maleic anhydride* (SMA) [$(COCH)_2O$] are available: SMA copolymers, with and without rubber impact modifier (e.g. DYLARK®) and SMA terpolymer alloys (e.g. CADON®). *K-Resin®* is a solid styrene-butadiene copolymer resin. Acrylic monomers are also used in conjunction with styrene (or styrene plus other monomers) to produce specialty resins. For example, there are transparent terpolymers of methyl methacrylate, butadiene, and styrene (MBS), and others of acrylonitrile, an acrylic monomer, and styrene (AAS). Ion-exchange resins or divinylbenzene-modified polystyrene are another variation. SB latexes are used in carpet backing and paper coatings. The other styrenics are used in paints, coatings, and floor polishes, plus many other uses.

SULFONE POLYMERS

A family of engineering thermoplastic resins characterized by the sulfone [SO_2] group. *Polysulfone* is made by the reaction of the disodium salt of bisphenol A [$(CH_3)_2C(C_6H_4OH)_2$] with 4,4'-dichlorodiphenyl sulfone(4,4'-DCDPS [$(C_6H_4Cl)_2SO_2$]. *Polyethersulfone* is made by the reaction of 4,4'-DCDPS with potassium hydroxide [KOH]. *Polyphenylsulfone* is similar to the other sulfone polymers. Typical applications for sulfone polymers are found in electrical/electronic uses and automotive parts.

THERMOPLASTIC POLYESTER (SATURATED)

A family of polyesters in which the polyester backbones are saturated and hence unreactive. The most common commercial types are: *PET* (polyethylene terephthalate) produced by polycondensation of ethylene glycol [CH_2OHCH_2OH] with either dimethyl terephthalate (DMT) [$C_6H_4(COOCH_3)_2$] or terephthalic acid (TPA) [$C_6H_4(COOH)_2$]; and *PBT* (polybutylene terephthalate) produced by the reaction of DMT with 1,4 butanediol [$NO(CH_2)_4OH$]. Typical applications are found in packaging, automotive, electrical, and consumer markets.

UREA-FORMALDEHYDE

Formed by the condensation reaction of formaldehyde [HCHO] and urea [$CO(NH_2)_2$]. These thermoset resins are clear water-white syrups or white powdered materials which can be dispersed in water to form colorless syrups. They cure at elevated temperatures with appropriate catalysts. Molding powders are made by adding fillers to the uncured syrups, forming a consistency suitable for compression and transfer molding. The liquid and dried resins find extensive use in laminates and chemically-resistant coatings. The molding compounds are formed into rigid electrical and decorative products.

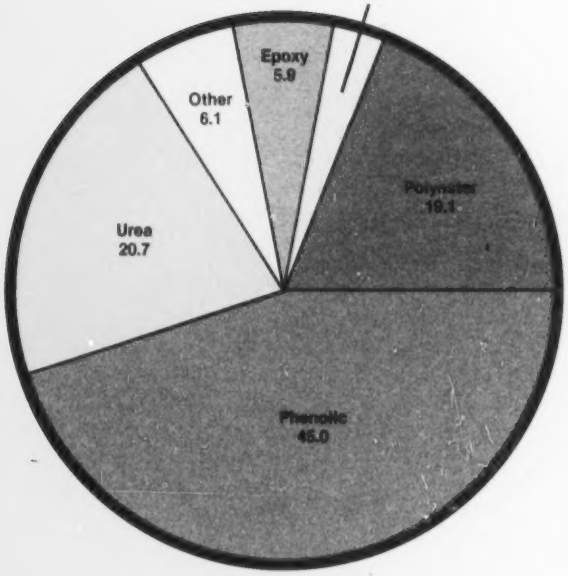
UNSATURATED POLYESTER

Thermosetting resins made by the condensation reaction between difunctional acids and glycols. The resulting polymer is then dissolved in styrene [$C_6H_5CHCH_2$] or other vinyl unsaturated monomer. The structures of the acids and glycols used and their proportions, especially the ratio of the unsaturated versus the saturated acid, and the type and amount of monomer used, are all tailored for each resin to balance economy, processing characteristics, and performance properties. One common formulation is the reaction of maleic anhydride [$(COCH)_2O$], phthalic anhydride [$C_6H_4(CO)_2O$], and propylene glycol [$CH_3CHOHCH_2OH$]. Both dicyclopentadiene [$(C_6H_5)_2$] and isophthalic acid [$C_6H_4(COOH)_2$] can be substituted for phthalic anhydride. Vinyl ester resins are linear reaction products of bisphenol A [$(CH_3)_2C(C_6H_4OH)_2$] and epichlorohydrin [CH_2OCHCH_2Cl] that are terminated with an unsaturated acid such as methacrylic acid [$CH_2C(CH_3)COOH$]. Typical applications are found in transportation, appliances, electrical, and construction markets.

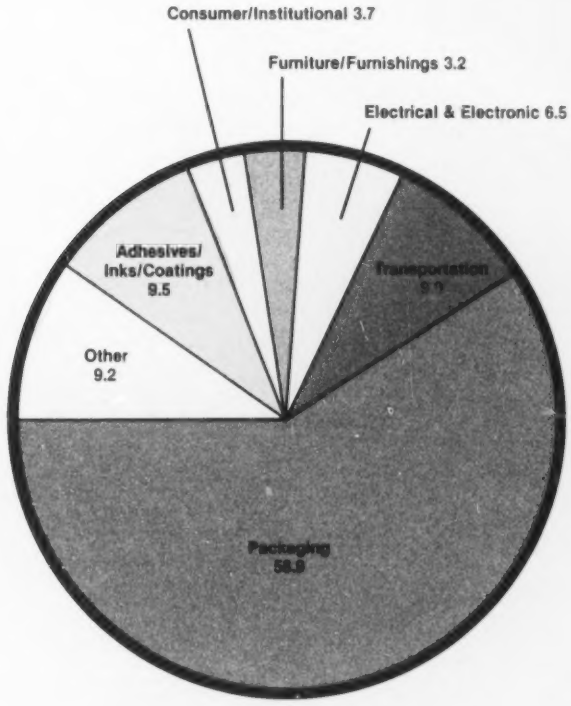
Sources: *Chemical Economics Handbook*, SRI International
Modern Plastics Encyclopedia
Whittington's Dictionary
The Condensed Chemical Dictionary

THERMOSETTING RESINS

Plastics which in their final state as finished articles are substantially infusible and insoluble. They are often liquids at some state of their manufacture or processing, which are cured by heat, catalysts or other chemical means. After being fully cured, thermosets cannot be resoftened by heat.



1983 PERCENT OF THERMOSET RESIN
SALES & CAPTIVE USE
BY MATERIAL



1983 PERCENT OF THERMOSET RESIN
SALES & CAPTIVE USE
BY MAJOR MARKET

EPOXY

MANUFACTURERS*

Celanese Specialties Co.
Ciba-Geigy Corp.
Dow Chemical U.S.A.
Morton Industries
Reichhold Chemicals Inc.
Shell Chemical Co.
Union Carbide Corp.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1983.

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	249	240
1975	198	187
1976	244	250
1977	261	278
1978	299	316
1979	361	332
1980	315	319
1981	336	332
1982	286	301
1983	334	331
COMPOUND GROWTH RATE		
1973-1983	4.1%	4.1%

	PERCENT OF TOTAL U.S. SALES & CAPTIVE USE
1974	0.90
1975	0.88
1976	0.93
1977	0.89
1978	0.90
1979	0.86
1980	0.91
1981	0.90
1982	0.86
1983	0.82

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

EPOXY

DOMESTIC CONSUMPTION BY END-USE

(in millions of pounds)

END-USE	1979	1980	1981	1982	1983
Bonding & adhesives	17	18	18	15	15
Flooring, paving and aggregates	20	19	20	18	19
Protective coatings	146	137	137	122	131
Fiber reinforced laminates & composites	60	63	66	58	74
Tooling, casting, and molding resins	31	26	29	24	28
All other uses	22	20	21	25	29
Total	296	283	291	262	296

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	*	*	*	*	*
Packaging	*	*	*	*	*
Building/Construction	28	48	49	44	36
Electrical/Electronic	66	55	58	60	73
Furniture/Furnishings	—	—	—	—	*
Consumer & Institutional	*	—	*	—	*
Industrial/Machinery	*	—	*	*	*
Adhesives, Inks & Coatings	159	150	151	134	118
All Other	43	30	33	24	69
Exports	36	36	41	39	35
Total	332	319	332	301	331

*Included in All Other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

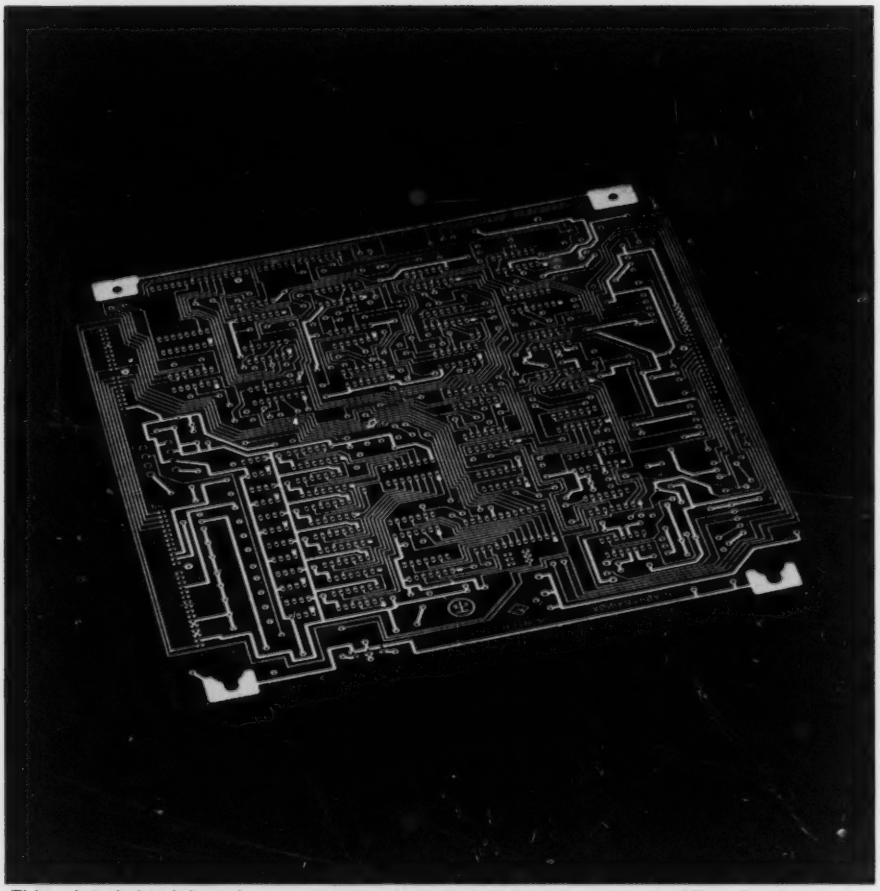
EPOXY

TYPICAL APPLICATIONS

Coatings
Electrical laminates
Floor/paving aggregates

Reinforced composites
Electrical/Electronic casting

Adhesives
and molding



This printed circuit board uses an epoxy-glass electrical laminate made of Epon® epoxy resin. The material is supplied by Shell Chemical Co.

PHENOLIC

MANUFACTURERS*

Acme Resins Co.
American Hoechst Corp.
Ametek, Haveg Div.
Ashland Chemical Co.
Bendix Corp.
Borden Chemical Co., Inc.
Chembond Corp.
Formica Corp.
General Electric Co.
Georgia-Pacific Corp.
Gulf Oil Products Co.
Inmont Corp.
Ironsides Resins, Inc.
Kesco Co.
Koppers Co.
Masonite Corp.
Monsanto Co.
Occidental Chemical Co.
Owens-Corning Fiberglas Corp.
Perkins Industries, Inc.
Pioneer Plastics Corp.
Plaslok Corp.
Plastics Engineering Co.
Polymer Applications Inc.
Polyrez Co., Inc.
Raymark Industries, Inc.
Reichhold Chemicals, Inc.
Rogers Corp.
Union Carbide Corp.
Uniroyal Chemical Div. Uniroyal, Inc.
Valite Div. Valentine Sugars, Inc.
Van Leer Containers, Inc.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1983.

PRODUCTION AND SALES & CAPTIVE USE**

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	1,335	1,305
1975	1,051	1,034
1976	1,340	1,305
1977	1,458	1,400
1978	1,827	1,788
1979	1,781	1,732
1980	1,499	1,517
1981	2,333	2,375
1982	2,006	2,060
1983	2,484	2,529
COMPOUND GROWTH RATE		
1973-1983	**n.c.**	**n.c.**

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE	
1974	4.89
1975	4.89
1976	4.84
1977	4.50
1978	5.10
1979	4.47
1980	4.31
1981	6.43
1982	5.87
1983	6.24

*Gross weight basis of reporting begun in 1981.
n.c. = not comparable.
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

PHENOLIC
DOMESTIC CONSUMPTION BY END-USE**

(in millions of pounds)

End-use	1979	1980	1981	1982	1983
Molding Compounds	310	246	249	192	232
Bonding & adhesive resins for:					
Laminating	109	97	134	127	166
Coated & bonded abrasives	40	34	37	25	28
Friction materials	39	35	29	25	32
Insulation materials	287	271	362	347	355
Foundry & shell molding	113	80	82	56	70
Plywood	511	445	1,110	1,012	1,309
Fibrous & granulated wood	119	88	201	146	179
Resins sold to Rubber Industry	23	28	24	23	27
All other	57	74	59	51	59
Protective coatings	21	24	26	18	19
All other uses	73	72	42	23	30
Total	1,702	1,494	2,355	2,045	2,506

**Gross weight basis of reporting begun in 1981.
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET**

(in millions of pounds)

Major Market	1979	1980	1981	1982	1983
Transportation	171	135	167	129	156
Packaging	11	10	*	*	*
Building/Construction	940	858	1,672	1,543	1,936
Electrical/Electronic	213	181	209	170	176
Furniture/Furnishings	7	11	25	26	*
Consumer & Institutional	40	33	*	*	44
Industrial/Machinery	21	21	27	*	11
Adhesives, Inks & Coatings	222	186	166	73	70
All Other	77	59	89	104	113
Exports	30	23	20	15	23
Total	1,732	1,517	2,375	2,060	2,529

**Gross weight basis of reporting begun in 1981
*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

PHENOLIC
TYPICAL APPLICATIONS

Wiring devices
Connectors
Transmission parts
Pulleys
Electrical switch gear
Closures
Handles
Telephone relay systems
Rubber tackifiers
Laminating plywood
Knobs
Power brake components

Exeltherm Xtra® phenolic foam insulation is installed in an aircraft hangar. The material is supplied by Koppers Company.

UNSATURATED POLYESTER

MANUFACTURERS*

Advance Coatings Corp.
Alpha Chemical Corp.
Ashland Chemical Co.
AZS Corp.
Cargill, Inc.
Cook Paint & Varnish Co.
Dow Chemical U.S.A.
Freeman Chemical Corp.
Glidden Coatings & Resin Div. SCM Corp.
ICI Americas, Inc.
Inmont Corp.
Interplastics Corp.
Koppers Co.
Owens-Corning Fiberglas Corp.
Pioneer Plastics Corp.
PPG Industries, Inc.
Reichhold Chemicals, Inc.
Shell Chemical Co.
Sherwin Williams Co., The
Sohio Chemical Co.
USS Chemicals Co.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1983.

PRODUCTION AND SALES & CAPTIVE USE
(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	911	907
1975	834	771
1976	1,042	959
1977	1,061	1,045
1978	1,209	1,199
1979	1,147	1,152
1980	947	949
1981	997	977
1982	865	851
1983	1,084	1,072
COMPOUND GROWTH RATE		
1973-1983	**0.3%**	**0.4%**

	PERCENT OF TOTAL U.S. SALES & CAPTIVE USE
1974	3.40
1975	3.64
1976	3.55
1977	3.36
1978	3.42
1979	2.98
1980	2.70
1981	2.64
1982	2.42
1983	2.65

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

UNSATURATED POLYESTER
MAJOR DOMESTIC MARKETS

(in millions of pounds)

	1979	1980	1981	1982	1983
DOMESTIC REINFORCED PLASTICS, TOTAL	**906**	**739**	**764**	**629**	**818**
Marine and marine accessories	227	171	169	156	215
Transportation	105	80	84	65	88
Auto, trucks, buses, etc.	86	63	65	53	75
Other transportation	19	17	19	12	13
Construction	325	287	301	279	340
General construction	122	114	122	114	135
Bathroom components & fixtures, general purpose tanks & pipes	106	79	78	75	93
Corrosion resistant tanks, pipes, etc.	97	94	101	90	112
Electrical generation, transmission and distribution	26	23	22	17	26
Consumer goods	85	66	66	51	81
Major appliances and parts	11	7	10	19	21
Recreational goods, toys, etc.	23	19	24	22	40
Other consumer goods	51	40	32	10	20
Gel coats	37	26	32	31	36
Other reinforced	101	86	90	30	32
DOMESTIC NON-REINFORCED PLASTICS, TOTAL	**231**	**214**	**202**	**214**	**244**
Castings	160	144	123	103	118
Furniture	7	6	7	4	4
Cultured marble & onyx	67	63	61	62	81
Other	86	75	55	37	33
Autobody putty	45	41	45	60	61
Surface and protective coatings	5	5	5	4	5
Bonding and adhesives	5	5	3	2	2
Other non-reinforced	16	19	26	45	58

Source: Quarterly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	362	261	259	244	316
Packaging	—	*	*	—	—
Building/Construction	434	384	401	353	496
Electrical/Electronic	39	25	33	26	52
Furniture/Furnishings	26	26	24	3	2
Consumer & Institutional	138	100	94	95	81
Industrial/Machinery	88	*	*	—	*
Adhesives, Inks & Coatings	15	10	9	7	*
All Other	36	132	146	115	115
Exports	14	11	11	8	10
Total	**1,152**	**949**	**977**	**851**	**1,072**

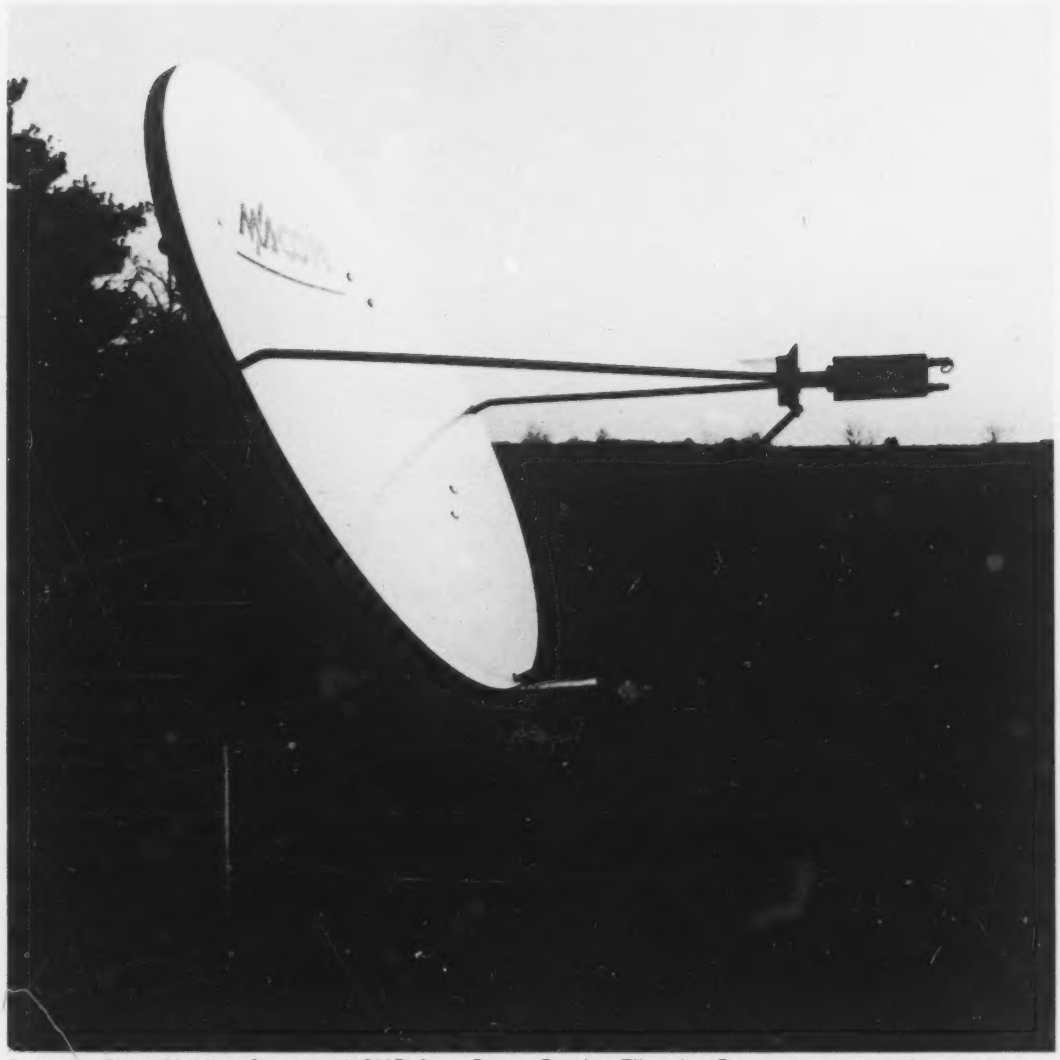
*Included in all other.

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

UNSATURATED POLYESTER

TYPICAL APPLICATIONS

Panels	Sanitary fixtures	Pleasure boats
Tanks	Synthetic marble	Bowling balls
Auto components	Recreational vehicles	Showerstalls



Polyester Sheet Molding Compound (SMC) from Owens-Corning Fiberglas Corp. was compression molded to produce this antenna reflector.

UREA

MANUFACTURERS*

American Cyanamid Co.
Borden Chemical Co., The
Celanese Specialties Co.
Chembond Corp.
Dan River Inc.
Georgia-Pacific Corp.
Grifftex Chemicals, Inc.
Guardsman Chemicals, Inc.
Kesco Co.
Maplechem Inc.
Monsanto Co.
Perkins Industries
Perstorp U.S., Inc.
Pioneer Plastics Corp.
Plastics Manufacturing Co.
Reichhold Chemicals, Inc.
Valchem Div. United Merchants, Inc.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1983.

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	835	822
1975	690	685
1976	821	809
1977	963	951
1978	1,122	1,103
1979	1,367	1,355
1980	1,165	1,147
1981	1,165	1,139
1982	998	976
1983	1,172	1,167
Compound Growth Rate		
1973-1983	3.1%	3.1%

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE

1974	3.08
1975	3.24
1976	3.00
1977	3.06
1978	3.15
1979	3.50
1980	3.26
1981	3.08
1982	2.78
1983	2.88

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

MELAMINE

MANUFACTURERS*

American Cyanamid Co.
American Hoechst Corp.
Borden Chemical Co., The
Celanese Specialties Co.
Chembond Corp.
Cook Paint & Varnish Co.
Dan River Inc.
Formica Corp.
Georgia-Pacific Corp.
Grifftex Chemicals, Inc.
Guardsman Chemicals, Inc.
Maplechem Inc.
Monsanto Co.
Owens-Corning Fiberglas Corp.
Perstorp U.S., Inc.
Pioneer Plastics Corp.
Plastics Manufacturing Co.
Reichhold Chemicals, Inc.

*Those manufacturers who participated in the SPI Monthly Statistical Report in 1983.

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	164	156
1975	115	117
1976	186	182
1977	200	203
1978	202	196
1979	200	192
1980	167	166
1981	179	175
1982	158	155
1983	180	181
Compound Growth Rate		
1973-1983	0.6%	0.3%

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE

1974	0.58
1975	0.55
1976	0.67
1977	0.65
1978	0.56
1979	0.50
1980	0.47
1981	0.47
1982	0.44
1983	0.44

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

UREA AND MELAMINE

DOMESTIC CONSUMPTION BY END-USE

(in millions of pounds)

END-USE	1979	1980	1981	1982	1983
Paper treating & coating resins	76	70	73	68	74
Bonding & adhesive resins for:					
Laminating	29	27	32	27	40
Plywood	86	74	74	64	63
Fibrous & granulated wood	1,029	896	884	759	918
Protective coatings	88	66	69	64	76
All other uses	215	162	158	132	155
Total	1,523	1,295	1,290	1,114	1,326

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION OF UREA/MELAMINE BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	24	*	*	*	*
Packaging	34	*	*	44	45
Building/Construction	915	833	820	712	844
Electrical/Electronic	52	*	*	*	*
Furniture/Furnishings	206	168	181	148	*
Consumer & Institutional	35	51	48	*	*
Industrial/Machinery	—	*	*	—	—
Adhesives, Inks & Coatings	134	99	90	65	*
All Other	123	144	151	145	438
Exports	24	18	24	17	21
Total	1,547	1,313	1,314	1,131	1,348

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

UREA AND MELAMINE
TYPICAL APPLICATIONS

UREA		MELAMINE	
Wiring devices	Buttons	Adhesives and bonding	Dinnerware
Toilet seats	Knobs	Buttons	Knobs
Handles	Adhesives and bonding	Handles	Ashtrays

MISCELLANEOUS THERMOSETS

(in millions of pounds)

PRODUCTION

Resin	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Alkyds	734	726	674	705	753	754	755	703	717	523
Furfuryl-type	4	4	8	8	n.a.	17	31	25	24	20
Silicones	18	18	12	15	18	16	20	12	17	13
Dicyandiamide	2	2	2	2	2	2	2	2	2	1
Other[1]	34	33	18	26	91	60	70	169	107	125

SALES

Resin	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Alkyds	397	403	380	471	434	415	408	392	420	284
Furfuryl-type	3	4	n.a.	n.a.	n.a.	16	30	25	23	18
Silicones	13	13	8	13	11	11	11	8	8	8
Dicyandiamide	2	2	1	2	2	2	2	2	2	1
Other[1]	13	19	21	24	70	49	61	121	78	104

n.a. = not available

[1]Includes acetone-formaldehyde, glyoxal-formaldehyde, polybutadiene, and other thermosets.

Source: *Synthetic Organic Chemicals*, U.S. International Trade Commission.

DISTRIBUTION OF POLYURETHANE FOAM SALES AND USE BY MAJOR MARKET

(in millions of pounds)

	Quantity					% of Total				
	1979	1980	1981	1982	1983	1979	1980	1981	1982	1983
Transportation	418	288	268	248	301	21.7%	16.8%	15.4%	14.8%	15.8%
Flexible	367	242	227	216	269	19.0	14.1	13.0	12.9	14.1
Rigid	51	46	41	32	32	2.7	2.7	2.4	1.9	1.7
Packaging	62	57	77	77	85	3.2	3.3	4.4	4.6	4.3
Flexible	31	23	35	34	38	1.6	1.3	2.0	2.0	2.0
Rigid	31	34	42	43	47	1.6	2.0	2.4	2.6	2.3
Furniture/Furnishings	973	872	898	859	872	50.4	50.9	51.5	51.3	45.7
Flexible	948	850	882	834	856	49.1	49.7	50.6	49.8	44.8
Rigid	25	22	16	21	16	1.3	1.2	0.9	1.5	0.9
Building/Construction	322	315	328	328	379	16.7	18.4	18.8	19.6	19.9
Electrical/Electronic	84	69	76	80	87	4.4	4.1	4.4	4.8	4.6
All Other	71	111	97	82	185	3.6	6.5	5.5	4.9	9.7
Total	1,930	1,712	1,744	1,674	1,909	100.0%	100.0%	100.0%	100.0%	100.0%

POLYURETHANE FOAM—DOMESTIC SALES & CAPTIVE USE

(in millions of pounds)

	1979	1980	1981	1982	1983	Compound Growth Rate 1978-1983
Flexible and Semi-Flexible Foam						
Bedding (excluding sofa beds)	152	139	143	125	149	−1.5%
Furniture	461	432	437	431	503	+0.8
Packaging	31	23	35	34	38	+2.9
Rug and Underlay	143	161	165	141	165	+4.5
Textile Laminates	42	38	36	34	39	+2.8
Transportation	352	242	227	216	269	− 7.2
Miscellaneous	44	58	40	43	35	−13.2
Scrap	150	80	101	103	113	− 3.6
Total Flexible and Semi-Flexible Foam	1,375	1,173	1,184	1,127	1,311	− 1.9%
Rigid Foam						
Appliances	84	69	76	80	87	+2.1%
Building Construction	322	315	328	328	379	+ 6.0
Furniture	25	22	16	21	16	−13.5
Marine Flotation	17	15	15	12	10	−11.1
Packaging	31	34	42	43	47	+14.4
Transportation	49	46	41	32	32	−11.2
Miscellaneous	27	38	42	31	27	+1.6
Total Rigid Foam	555	539	560	547	598	+ 2.8%
Grand Total Foam	1,930	1,712	1,744	1,674	1,909	− 0.5%

Source: Polyurethane Foam End-use Survey,
SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

ISOCYANATES
(in millions of pounds)

	PRODUCTION			SALES & CAPTIVE USE
Year	Total	TDI*	Other Isocyanates	Total
1979	1,248	681	567	1,234
1980	1,126	536	590	1,079
1981	1,147	537	610	1,138
1982	1,042	547	495	1,052
1983	1,156	624	532	1,135

*Toluene Diisocyanate (80/20 mixture)

POLYETHER POLYOLS
(in millions of pounds)

Year	Production	Sales & Captive Use
1979	1,510	1,491
1980	1,225	1,231
1981	1,264	1,266
1982	1,111	1,209
1983	1,296	1,286

POLYESTER POLYOLS
(in millions of pounds)

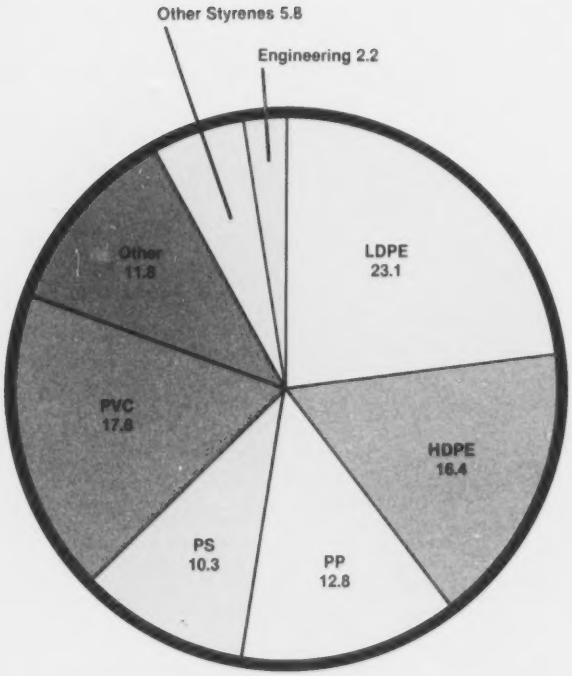
Year	Production	Sales & Captive Use
1979	43	41
1980	42	40
1981	47	46
1982	28	28
1983	29	26

PARTICIPATING COMPANIES—1983	Isocyanates	Polyether Polyols	Polyester Polyols
BASF Wyandotte Corp.	X	X	
Chemetic Systems		X	
Choate Chemical		X	
Dow Chemical U.S.A.	X	X	
E.I. duPont de Nemours & Co.		X	
ICI Americas	X		
Mobay Chemical Corp.	X	X	X
Olin Corp.	X	X	
Owens-Corning Fiberglas Corp.		X	
PPG Industries		X	
Quaker Oats Co.		X	
Reichhold Chemicals, Inc.		X	
Ruco Div. Occidental Chemicals Corp.			
Stepan Chemical Co.		X	
Texaco, Inc.		X	
U.C.T., Inc.		X	
Union Carbide Corp.		X	X
Uniroyal Chemical Co.		X	X
The Upjohn Co.	X	X	
Witco Chemical Co.		X	X

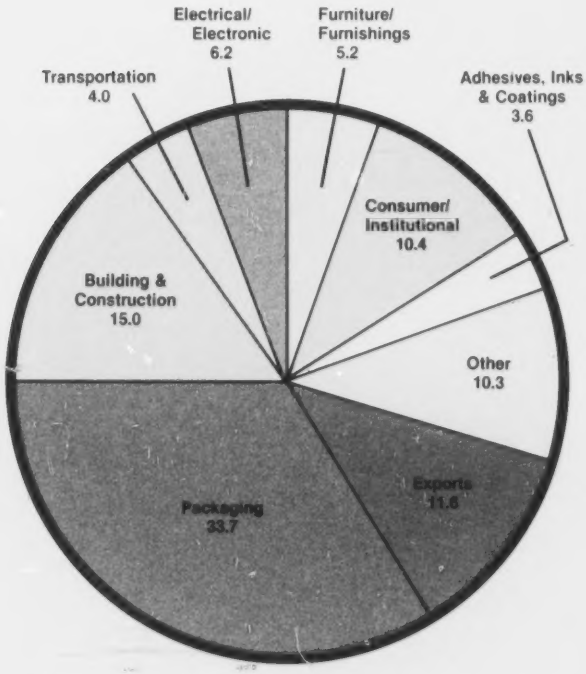
Source: Quarterly Polyols and Isocyanates Reports, SPI Committee on Resin Statistics as compiled by Ernst & Whinney.

THERMOPLASTIC RESINS

Plastics which in their final state as finished articles are capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature and physical change.



1983 PERCENT OF THERMOPLASTIC SALES & CAPTIVE USE BY MATERIAL



1983 PERCENT OF THERMOPLASTIC SALES & CAPTIVE USE BY MAJOR MARKET

ABS AND SAN

MANUFACTURERS*

Borg Warner Chemicals
Dow Chemical U.S.A.
B.F. Goodrich Chemical Co.
W. R. Grace & Co.
Mobay Chemical Co.
Monsanto Company

*Those companies who participated in the SPI Monthly Statistical Report in 1983.

PRODUCTION AND SALES & CAPTIVE USE
(millions of pounds)

	PRODUCTION		SALES & CAPTIVE USE	
YEAR	ABS	SAN	ABS	SAN
1974	857	109	816	119
1975	642	109	621	75
1976	988	113	925	104
1977	1,069	115	1,057	113
1978	1,134	120	1,118	121
1979	1,191	124	1,183	126
1980	920	111	916	103
1981	916	107	900	105
1982	740	91	737	85
1983	n.a.	93	n.a.	91
Compound Growth Rate 1973-1983	n.a.	−2.6%	n.a.	−2.7%

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE

	ABS	SAN
1974	3.06	0.45
1975	2.94	0.35
1976	3.43	0.39
1977	3.40	0.36
1978	3.19	0.35
1979	3.06	0.33
1980	2.60	0.29
1981	2.44	0.28
1982	2.10	0.24
1983	n.a.	0.23

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

ABS AND SAN

MAJOR DOMESTIC MARKETS

(in millions of pounds)

MARKET	1979	1980	1981	1982	1983
ABS					
Consumer & Institutional	n.a.	n.a.	132	104	n.a.
Pipe, Conduit & Fittings	302	208	180	111	n.a.
Electrical & Electronic	229	193	195	181	n.a.
Transportation	n.a.	154	161	145	n.a.
Other	593	304	180	148	n.a.
Total	1,124	859	848	689	n.a.
SAN					
Total	108	90	91	75	80
Grand Total	1,232	949	939	764	n.a.

n.a. = not available.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION OF ABS & SAN BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983[a]
Transportation	317	185	177	156	267
Packaging	33	26	29	*	51
Building/Construction	341	234	194	124	197
Electrical/Electronic	257	265	209	203	246
Furniture/Furnishings	16	8	*	*	7
Consumer & Institutional	139	93	165	129	168
Industrial/Machinery	15	13	*	*	47
Adhesives, Inks & Coatings	—	—	—	—	27
All Other	114	125	165	153	175
Exports	77	69	66	57	144
Total	1,309	1,019	1,005	822	1,329

*Included in all other [a]Includes Other Styrene Based Polymers

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

ABS AND SAN
TYPICAL APPLICATIONS

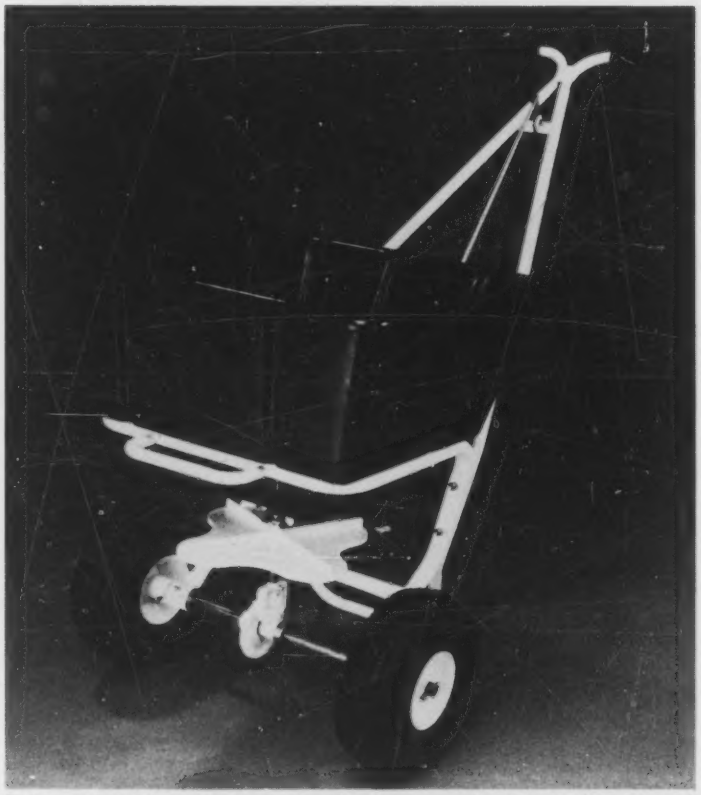
ABS		SAN	
Household appliances	Business machines	Automotive trim	Boat hulls
Telephones	Refrigerator liners	Marine instruments	Solar collectors
Bath tubs	Sporting goods	Tractor components	Swimming pool components

Typical applications for Cycolac® ABS engineering thermoplastics include enclosures for telephones, business machines and personal computers. The material is supplied by Borg-Warner Chemicals, Inc.

ENGINEERING THERMOPLASTIC RESINS

TYPICAL APPLICATIONS

Acetal (AC)	Sinks, faucets, electrical switches, gears, aerosol bottles, meat hooks, lawn sprinklers, ballcocks, shaver cartridges, zippers, telephone pushbuttons.
Polycarbonate (PCO)	Helmets, power tool housings, battery cases, safety glass, auto lenses, 5 gal. bottles.
Polyphenylene Sulfide (PPS)	Electrical connectors, coil forms, lamp housings.
Thermoplastic Polyester (TP)	Electrical bobbins, TV tuners, fuse cases, bearings, cams, auto ignition coil caps, speedometer frames, pump impellers and housings.
Polysulfone (PSO)	Electrical connectors, meter housings, coffeemakers, camera bodies, auto switch and relay bases, light-fixture sockets, fuel cell components, battery cases.
Modified Polyphenylene Oxide (PPO)	Auto dashboards, pumps, shower heads, plated auto grilles and trim, appliance housings, wiring splice devices, protective shields.
Polyimide (PI)	Radomes, printed circuit boards, turbine blades.
Polyamide-imide (PAI)	Valves, gears, pumps, high temperature magnet wire enamels.



This broadcast spreader for professional applications of seed and chemicals on grass resists damage because key parts are made of Delrin® super tough acetal resin. The material is supplied by E.I. DuPont de Nemours & Co.

ENGINEERING THERMOPLASTIC RESINS

MANUFACTURING

KNOWN MANUFACTURERS	AC	PCO	PPS	TP	PSO	PPO	PI	PAI	FLUORO-POLYMERS
Allied				X					X
American Hoechst				X					
Amoco Chemical							X	X	
Celanese Engineering Resins	X			X					
Dow Chemical		X							
Dupont	X			X			X		X
Eastman Chemical				X					
GAF				X					
General Electric		X		X		X	X		
Goodyear				X					
ICI Americas									X
Mobay Chemical		X							
Pennwalt Corp.									X
Phillips Petroleum			X						
Rohm and Haas				X					
Union Carbide					X				

PRODUCTION AND SALES & CAPTIVE USE

(in millions of pounds and dollars)

YEAR	PRODUCTION	SALES & CAPTIVE USE	SALES (EXCL. CAPTIVE & EXPORTS)
1974	548	526	$381
1975	436	433	385
1976	n.a.	n.a.	n.a.
1977	605	576	486
1978	648	639	579
1979	729	709	699
1980	673	645	715
1981	676	633	806
1982	569	596	755
1983	731	781	979

COMPOUND GROWTH RATE OF SALES & CAPTIVE USE	
1978-1983	4.1%
1982-1983	31.0%

Source: SPI Committee on Resin Statistics as compiled by Ernst & Whinney

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	101	78	76	80	123
Packaging	8	1	1	1	2
Building & Construction	97	86	96	82	76
Electrical/Electronic	231	216	211	192	275
Consumer/Institutional	38	32	37	45	82
Industrial/Machinery	67	55	58	52	75
Other	21	42	34	18	26
Exports	146	106	120	126	122
Total	709	645	633	596	781

Source: Industry estimates.

n.a. = not available

U.S. SALES OF FLUOROPOLYMER RESINS (GRANULAR TYPE ONLY)

(in thousands of pounds)

	1979	1980	1981	1982	1983
Virgin, First Quality	7,819	7,310	7,699	5,651	6,898
Filled Resin, including colors	3,351	2,846	3,265	2,283	3,131
Miscellaneous lubricants, release compounds, etc.[1]	3,234	3,349	3,503	2,493	2,524
Total	14,404	13,505	14,467	10,427	12,553

[1] Includes broad specification second quality.
Source: SPI's Fluoropolymers Division.

COMPOUND GROWTH RATE
1978-1983

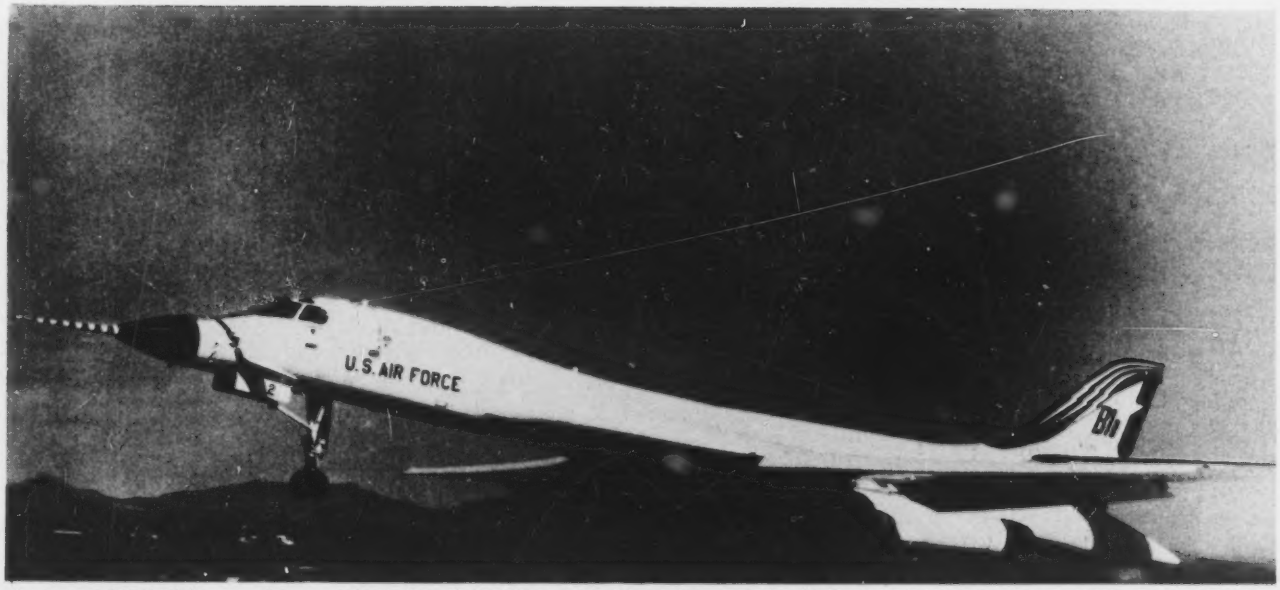
Virgin, First Quality	– 0.2%
Filled resin, including colors	– 0.4%
Miscellaneous lubricants, release compounds, etc.	– 2.3%
Total	– 0.7%

SUPPLIERS OF GRANULAR PTFE RESINS

Allied Chemical Corp.
American Hoechst Corp.
Custom Compounding
E.I. duPont de Nemours & Co.
ICI Americas
LNP Corporation
Mikro Technik
Montedison USA

FLUOROPOLYMERS
TYPICAL APPLICATIONS

Plenum cable	Chemical processing equipment	Electrical components
Non-stick coatings	Filter housings	Tower packings
Wire ties	Valves	Heat-shrinkable tubing



A sleeve of Halar® fluoropolymer protects bundled wiring and cable systems on the Air Force's B-1 bomber. The material is supplied by Allied Corp.

HIGH DENSITY POLYETHYLENE

MANUFACTURING

KNOWN MANUFACTURERS	ESTIMATED CAPACITY AS OF DECEMBER 31: (millions of pounds) 1983	1984
Allied Corp.	750	750
American Hoechst Corp.	250	250
Amoco Chemicals Corp.	340	340
ARCO Chemicals Co.[a]	325	—
Chemplex Company	325	325
Dow Chemical U.S.A.	380	380
DuPont, E.I. de Nemours & Co.	865	865
Exxon Chemical USA	—	60
Gulf Oil Chemicals	570	570
Himont U.S.A.	15	15
Mobil Chemical Co.	—	50
Phillips Petroleum Co.	1,400	1,400
Soltex Polymers	750	750
Union Carbide Corp.	330	—
U.S. Industrial Chemicals Co.	550	875
Total	6,890	6,630

[a]Sold to USI in 1984.

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

UTILIZATION RATE (%)	
1974	89.7
1975	70.6
1976	79.9
1977	84.8
1978	85.8
1979	94.1
1980	74.4
1981	78.3
1982	76.5
1983	82.6

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	2,837	2,676
1975	2,468	2,305
1976	3,125	3,127
1977	3,652	3,557
1978	4,201	4,165
1979	5,010	4,893
1980	4,405	4,394
1981	4,695	4,683
1982	4,928	5,024
1983	5,691	5,707
Compound Growth Rate 1973-1983	8.0%	7.6%

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE	
1974	10.03
1975	10.89
1976	11.59
1977	11.44
1978	11.88
1979	12.64
1980	12.49
1981	12.67
1982	14.31
1983	14.09

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

HIGH DENSITY POLYETHYLENE
DOMESTIC CONSUMPTION BY END-USE

(in millions of pounds)

END-USE	1979	1980	1981	1982	1983
Film (12 mils & below)	212	201	281	288	375
Sheet (over 12 mils)	66	55	52	64	76
Injection molding	1,074	938	997	1,102	1,188
Wire & cable	126	106	111	110	112
Extrusion coating	30	28	33	16	n.a.
Blow molding	1,724	1,573	1,696	1,714	1,808
Pipe & conduit	400	369	408	395	471
Other extruded products	19	24	18	25	42
All other uses	634	573	626	633	634
Total	4,285	3,867	4,222	4,347	4,706

n.a. = not available.
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	90	85	63	49	121
Packaging	2,190	2,049	2,367	2,565	2,591
Building/Construction	445	428	486	441	518
Electrical/Electronic	210	167	146	142	123
Furniture/Furnishings	14	*	*	*	*
Consumer & Institutional	496	495	482	421	526
Industrial/Machinery	106	*	102	95	109
Adhesives, Inks & Coatings	—	—	*	*	*
All Other	733	644	576	634	718
Exports	609	526	461	677	1,001
Total	4,893	4,394	4,683	5,024	5,707

*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

HIGH DENSITY POLYETHYLENE

TYPICAL APPLICATIONS

Grocery bags
Bottles
Agricultural tanks
Florist tissue
Cables
Gasoline tanks
55-gal. drums
Shipping containers
Seating

Containers used to package photographic chemicals, vegetable or motor oil, cake batter, household detergents and toner for copiers are extrusion blow molded from Petrothene® LR 734 high density polyethylene supplied by U.S. Industrial Chemicals Co.

LATEX MATERIALS

SIGNIFICANT PRODUCERS*

Air Products & Chemicals	B.F. Goodrich Chemical	Polysar Corp.
American Synthetic Rubber	Goodyear Tire & Rubber	Reichhold Chemicals
Borden Chemical	W.R. Grace	Rohm and Haas
Dow Chemical	Monsanto Company	Union Carbide Corp.
DuPont	Morton Chemical	Union Chemical
H.B. Fuller Company	National Starch	U.S. Industrial Chemicals
General Tire & Rubber	Occidental Chemical	USS Chemicals

*Those producers in the SPI statistical report.

Production by product type and end-use is as follows:

PRODUCT TYPE	APPROXIMATE % OF TOTAL
Polyvinyl acetate homopolymers and copolymers	52
Styrene/butadiene polymers	41
All other	7
	100

END-USE	APPROXIMATE % OF TOTAL
Export	1
Domestic	99
Emulsion paint	19
Adhesives	20
Paper treating and coating	27
Textile and non-woven	6
Carpet backing	17
Other	10
	100

STYRENE BUTADIENE & OTHER STYRENE BASED LATEXES

Significant producers are: Dow, General Tire & Rubber, Goodyear, W.R. Grace, Monsanto, Morton Industries, Occidental, Polysar, Reichhold, Union Chemical and USS Chemicals.

PRODUCTION AND SALES & CAPTIVE USE

(thousands of pounds)

		SALES & CAPTIVE USE*				
Year	Production	Paper Treating	Textile Treating	Carpet Backing	All Other	Total
1979	736,866	21,694	24,644	360,961	328,708	736,007
1980	631,816	27,445	24,734	293,059	286,805	632,043
1981	674,188	32,024	28,152	258,740	331,617	650,533
1982	510,160	24,211	12,829	199,461	267,760	504,261
1983	701,673	26,884	19,438	298,649	353,773	698,744

*Data may not be comparable due to variations in participation.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics as compiled by Ernst & Whinney.

LOW DENSITY POLYETHYLENE

MANUFACTURING

KNOWN MANUFACTURERS	ESTIMATED CAPACITY AS OF DECEMBER 31:[1] (millions of pounds) 1983	1984
Chemplex Company	400	400
Dow Chemical U.S.A.	1,400	1,600
DuPont, E.I. de Nemours & Co.	700	700
Eastman Chemical Products	600	600
El Paso Chemical Co.	400	400
Exxon Chemical U.S.A.	1,175	1,375
Gulf Oil Chemicals	900	900
Mobil Chemical Co.	775	775
Northern Petrochemical Co.	550	800
Soltex Polymers	—	30
Union Carbide Corp.	1,100	1,500
U.S. Industrial Chemicals Co.	650	900
Total	8,650	9,980

[1]Includes Linear Low Density

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

UTILIZATION RATE (%)	
1974	97.0
1975	72.6
1976	82.9
1977	81.8
1978	88.9
1979	97.7
1980	86.1
1981	78.8
1982	80.2
1983	93.0

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	5,973	5,998
1975	4,743	4,725
1976	5,813	5,765
1977	6,471	6,488
1978	7,111	7,147
1979	7,793	7,815
1980	7,291	7,467
1981	7,693	7,516
1982	7,503	7,687
1983	8,041	8,045
Compound Growth Rate 1973-1983	3.3%	3.1%

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE	
1974	22.47
1975	22.33
1976	21.37
1977	20.86
1978	20.38
1979	20.19
1980	21.22
1981	20.34
1982	21.89
1983	19.86

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

LOW DENSITY POLYETHYLENE
DOMESTIC CONSUMPTION BY END-USE
(in millions of pounds)

END-USE	1979	1980	1981	1982	1983
Film (12 mils & below)	4,363	4,004	4,077	4,209	4,628
Sheet (over 12 mils)	26	18	14	18	n.a.
Injection molding	650	519	524	507	657
Wire & cable	424	335	347	278	310
Extrusion coating	539	517	564	544	573
Blow molding	60	65	60	42	42
Pipe & conduit	33	22	25	23	25
Other extruded products	80	56	60	46	92
All other uses	742	784	862	876	800
Total	6,917	6,320	6,533	6,543	7,127

n.a. = not available
Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET
(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	56	*	53	*	*
Packaging	4,796	4,582	4,602	4,623	5,377
Building/Construction	245	186	148	225	226
Electrical/Electronic	500	416	431	345	374
Furniture/Furnishings	*	15	15	*	*
Consumer & Institutional	672	570	598	487	560
Industrial/Machinery	*	*	*	*	*
Adhesives, Inks & Coatings	27	*	*	46	*
All Other	621	551	685	817	589
Exports	898	1,147	984	1,144	919
Total	7,815	7,467	7,516	7,687	8,045

*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

LOW DENSITY POLYETHYLENE

TYPICAL APPLICATIONS

Stretch wrap	Squeeze bottles	Closures
Diaper liners	Housewares	Pipe
Household cling wrap	Lids	Toys

A wide variety of bags are made of low density polyethylene coextruded film. The material is supplied by U.S. Industrial Chemicals Co.

NYLON

MANUFACTURING

KNOWN MANUFACTURERS	ESTIMATED CAPACITY AS OF DECEMBER 31: (millions of pounds) 1983	1984
Allied Corp.	80	80
Badische Corp.	15	20
Belding Chemical Industries	4	6
Celanese Engineering Resins Co.	40	40
Custom Resins, div. Bemis Co.	18	18
DuPont, E.I. de Nemours & Co.	165	180
Monsanto Company	65	80
Nylon Corp. of America	16	16
Rilsan Corp.	15	15
Shakespeare Co.	4	4
Wellman, Inc.	8	11
Total	430	470

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

UTILIZATION RATE (%)	
1974	83.3
1975	56.5
1976	80.2
1977	70.8
1978	74.5
1979	79.8
1980	64.0
1981	70.6
1982	53.1
1983	74.7

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	204	183
1975	135	143
1976	247	221
1977	254	250
1978	275	278
1979	327	315
1980	274	271
1981	312	288
1982	228	247
1983	321	329
COMPOUND GROWTH RATE		
1973-1983	4.6%	5.6%

NYLON

PERCENT OF TOTAL U.S. SALES & CAPTIVE USE
1974 0.69
1975 0.68
1976 0.82
1977 0.80
1978 0.79
1979 0.81
1980 0.77
1981 0.78
1982 0.70
1983 0.81

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DOMESTIC CONSUMPTION BY END-USE

(in thousands of pounds)

END—USE	1979	1980	1981	1982	1983
Automotive and truck	100,878	77,972	89,115	69,909	109,949
Electrical and Electronic[1]	42,691	34,792	32,857	28,870	36,144
Appliances	14,684	7,061	8,549	6,847	6,804
Film and Coating	24,202	27,918	28,740	31,879	40,156
Wire and Cable	15,500	16,824	18,999	15,898	18,733
Monofilament	11,417	11,928	15,593	10,126	15,184
Consumer[2]	19,569	21,120	16,533	14,967	20,187
Others	56,414	50,434	59,159	52,029	57,896
Total	285,355	248,049	269,545	230,525	305,053

[1]Includes electrical and electronic applications not assignable to automotive and truck or appliance markets.
[2]Includes such items as housewares, brushes, combs, sporting goods, cameras and toys.

Source: SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	96	81	92	74	109
Packaging	31	28	32	33	40
Building/Construction	9	*	*	*	*
Electrical/Electronic	59	53	57	50	60
Furniture/Furnishings	*	8	8	*	9
Consumer & Institutional	15	17	17	13	*
Industrial/Machinery	26	20	26	21	28
Adhesives, Inks & Coatings	*	*	*	*	*
All Other	50	41	37	38	59
Exports	29	23	19	18	24
Total	315	271	288	247	329

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

NYLON

TYPICAL APPLICATIONS

Electrical connectors
Fender extensions
Brush bristles
Wire jackets
Power tool housings
Fishing line
Emission cannisters
Cooking bags
Sutures

The Pura-Trol oil purifier and conditioner is made from Celanese Nylon 1503-2 for the housing, base, stem and plates. The resin is a 33% glass fiber reinforced, heat stabilized 6/6 nylon supplied by Celanese Engineering Resins Co.

POLYPROPYLENE

MANUFACTURING

KNOWN MANUFACTURERS	ESTIMATED CAPACITY AS OF DECEMBER 31: (millions of pounds) 1983	1984
Amoco Chemicals Co.	550	550
ARCO Chemicals Co.	400	400
Eastman Chemical Products, Inc.	140	140
El Paso Chemical Co.	275	330
Exxon Chemical U.S.A.	555	555
Gulf Oil Chemicals Company	400	400
Himont U.S.A.	1,250	1,340
Northern Petrochemical Company	200	200
Phillips Petroleum Company	200	200
Shell Chemical Company	600	625
Soltex Polymer Corp.	200	200
USS Chemicals Co.	500	500
Total	5,270	5,440

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

UTILIZATION RATE (%)	
1974	83.0
1975	62.6
1976	83.0
1977	82.5
1978	66.8
1979	76.3
1980	70.2
1981	78.2
1982	68.3
1983	84.1

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	2,249	2,200
1975	1,902	1,903
1976	2,632	2,536
1977	2,747	2,698
1978	3,074	3,055
1979	3,841	3,894
1980	3,648	3,714
1981	3,955	3,888
1982	3,477	3,623
1983	4,434	4,464
COMPOUND GROWTH RATE		
1973-1983	7.4%	7.2%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYPROPYLENE

	PERCENT OF TOTAL U.S. SALES & CAPTIVE USE
1974	8.24
1975	8.99
1976	9.40
1977	8.67
1978	8.71
1979	10.06
1980	10.56
1981	10.52
1982	10.32
1983	11.02

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DOMESTIC CONSUMPTION BY END-USE

(in millions of pounds)

END-USE	1979	1980	1981	1982	1983
Injection molding, total	1,219	1,119	1,243	1,073	1,232
Appliances	99	87	94	72	96
Consumer products	278	301	359	273	301
Rigid packaging	208	225	266	291	351
Transportation	350	252	247	225	293
All other injection molding	284	254	277	212	191
Blow molding	62	63	65	68	90
Film (10 mils & below)	282	298	303	290	364
Sheet	31	36	35	19	33
Other extruded products (including wire & cable, pipe & conduit, and extrusion coating)	97	84	99	93	106
Fiber & filaments	1,020	963	1,036	866	1,221
All other uses	469	472	421	476	618
Total	3,180	3,035	3,202	2,885	3,664

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	260	230	266	199	293
Packaging	722	720	812	757	845
Building/Construction	*	*	*	31	22
Electrical/Electronic	210	196	248	161	242
Furniture/Furnishings	759	727	813	772	983
Consumer & Institutional	539	505	487	421	580
Industrial/Machinery	54	52	56	*	*
Adhesives, Inks & Coatings	*	*	*	*	*
All Other	636	604	521	545	699
Exports	714	680	685	737	800
Total	3,894	3,714	3,888	3,623	4,464

*Included in all other
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYPROPYLENE
TYPICAL APPLICATIONS

- Retort pouches
- Tobacco wrap
- Bottles
- Battery cases
- Carpet backing
- Threaded caps
- Filter plates
- Toys
- Microwave oven containers

This battery case is made with Shell Chemical Co.'s high impact polypropylene.
Courtesy of Shell Chemical Company

POLYSTYRENE

MANUFACTURING

KNOWN MANUFACTURERS	ESTIMATED CAPACITY AS OF DECEMBER 31: (millions of pounds) 1983	1984
A & E Plastic Pak	30	30
American Hoechst Corp.	600	600
Amoco Chemicals Corp.	400	400
ARCO Chemicals Co.	450	450
Asoma Chemicals, Inc.	45	45
BASF Wyandotte Corp.	180	180
Cosden Oil & Chemical Company	450	450
Dart Container	40	50
Dow Chemical Corp.	1,000	1,000
Georgia Pacific	—	60
Goodson Chemical Co.	40	40
Gulf Oil Chemicals	300	350
Huntsman Chemical Co.	300	300
Kama Corp.	30	30
Mobil Chemical Corp.	340	400
Monsanto Company	750	750
Polysar Group	375	375
RussteK	—	20
Texstyrene Plastics Co.	10	10
Vititek	5	5
Total	5,345	5,545

Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

	UTILIZATION RATE (%)
1974	74.3
1975	51.5
1976	61.0
1977	66.7
1978	75.9
1979	77.0
1980	67.1
1981	70.2
1982	61.7
1983	68.7

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1974	3,364	3,203
1975	2,662	2,640
1976	3,195	3,145
1977	3,446	3,557
1978	3,823	3,870
1979	4,005	3,997
1980	3,521	3,518
1981	3,621	3,604
1982	3,191	3,200
1983	3,567	3,606
COMPOUND GROWTH RATE 1973-1983	0.7%	0.5%

POLYSTYRENE

	PERCENT OF TOTAL U.S. SALES & CAPTIVE USE
1974	12.00
1975	12.48
1976	11.66
1977	11.44
1978	11.04
1979	10.32
1980	10.00
1981	9.75
1982	9.11
1983	8.90

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DOMESTIC CONSUMPTION BY END-USE

(in millions of pounds)

END-USE	1979	1980	1981	1982	1983
Straight Polystyrene[a]	1,906	1,761	1,793	1,669	1,811
Rubber-Modified Polystyrene[a]	2,091	1,757	1,811	1,531	1,718
Total	3,997	3,518	3,604	3,200	3,529
Molding	1,901	1,596	1,638	1,368	1,516
Extrusion	1,314	1,083	1,142	1,060	1,238
Expandable Polystyrene Beads	445	431	416	426	440
All Other Uses	175	240	257	251	335
Total Domestic	3,835	3,350	3,453	3,105	3,529

[a]Includes exports 1979-1982

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

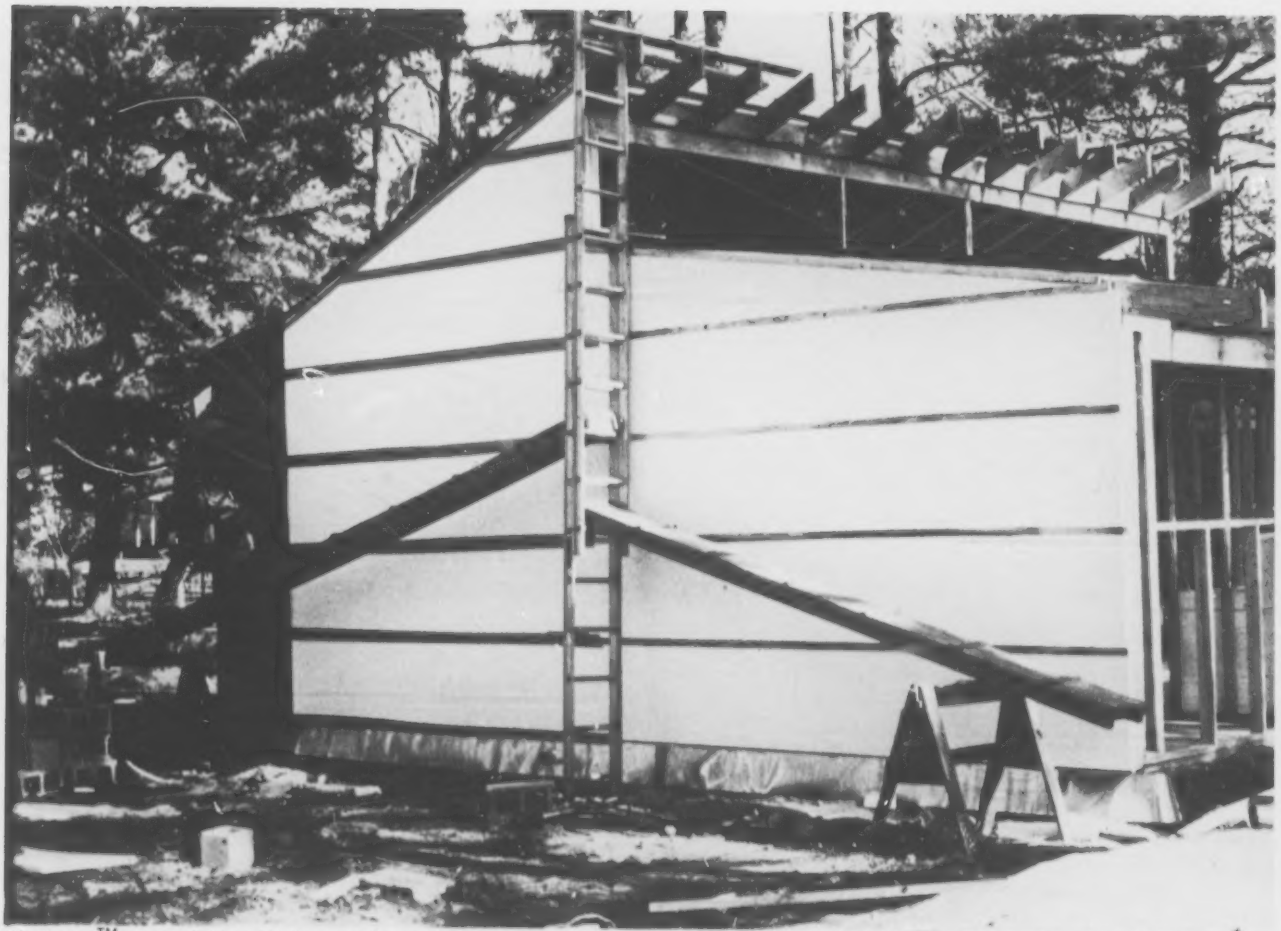
MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	23	13	16	4	12
Packaging	1,424	1,349	1,494	1,288	1,486
Building/Construction	350	277	273	289	294
Electrical/Electronic	383	301	360	311	307
Furniture/Furnishings	118	74	62	39	47
Consumer & Institutional	927	779	756	745	820
Industrial/Machinery	26	*	*	*	*
Adhesives, Inks & Coatings	—	*	*	*	*
All Other	585	557	493	429	563
Exports	161	168	150	95	77
Total	3,997	3,518	3,604	3,200	3,606

*Included in all other

Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYSTYRENE
TYPICAL APPLICATIONS

Disposable serviceware	Video cassettes	Business machines
Pallets	Appliance parts	Syringes
Trays	Roofing insulation	Egg cartons



Hostapor™ expandable polystyrene sheating is used in the Solar 2001 home. The material is supplied by American Hoechst Corp.

POLYVINYL CHLORIDE

MANUFACTURING

KNOWN MANUFACTURERS	ESTIMATED CAPACITY AS OF DECEMBER 31: (millions of pounds) 1983	1984
Air Products & Chemicals	150	350
Borden Chemical Company, The	700	800
Certain-Teed Products Corp.	220	220
Conoco Chemicals (Vista)	715	715
Ethyl Corp.[a]	315	—
Formosa Plastics	740	800
General Tire & Rubber Company	120	120
Georgia-Pacific Corp.	700	1,015
B.F. Goodrich Chemical Company, The	1,850	1,850
Goodyear Tire & Rubber Company, The	70	70
Keysor-Century Corp.	50	50
Occidental Chemical Co.	525	525
Pantasote Co. of New York, The	50	50
Shintech, Inc.	600	800
Tenneco Chemicals	900	950
Union Carbide Corp.	145	145
Total	7,850	8,460

[a]Sold to Georgia Pacific in 1983.
Source: Individual company figures are derived from published company reports, announcements to the trade press and other published trade sources.

UTILIZATION RATE (%)	
1974	87.9
1975	65.4
1976	80.0
1977	82.8
1978	90.8
1979	86.3
1980	76.8
1981	75.8
1982	72.1
1983	79.2

PRODUCTION AND SALES & CAPTIVE USE

(millions of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE	PERCENT OF TOTAL U.S. SALES & CAPTIVE USE	
1974	4,850	4,711	1974	17.65
1975	3,648	3,615	1975	17.08
1976	4,716	4,638	1976	17.19
1977	5,253	5,232	1977	16.82
1978	5,723	5,810	1978	16.57
1979	6,119	6,138	1979	15.85
1980	5,470	5,407	1980	15.37
1981	5,707	5,601	1981	15.16
1982	5,326	5,455	1982	15.54
1983	6,066	6,152	1983	15.19
Compound Growth Rate				
1973-1983	2.9%	2.7%		

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYVINYL CHLORIDE
DOMESTIC CONSUMPTION BY END-USE

(in millions of pounds)

End-use	1979	1980	1981	1982	1983
Calendering, total	719	623	666	594	682
Flooring	173	138	147	149	160
Textile	110	94	73	64	105
All other calendering	436	391	446	381	417
Coating, total	489	370	314	267	361
Flooring	186	125	123	99	149
Textile & paper coating	138	119	100	87	119
Protective coatings	83	67	41	38	45
Adhesives & all other coatings	82	59	50	43	48
Extrusion, total	3,514	2,978	3,149	3,129	3,496
Wire & cable	409	368	367	328	350
Film & sheet	292	253	287	312	309
Rigid pipe & tubing (except fittings)	2,323	1,865	2,033	2,014	2,273
All other extrusions	490	492	462	475	564
Molding, total	503	415	372	364	430
Bottles	82	98	92	103	166
Sound records	160	114	104	112	80
Fittings (rigid pipe & tubing)	113	92	102	99	80
All other molding	148	111	74	50	78
Paste processes (except coating), total	184	154	182	172	166
Plastisol formulation	93	81	99	85	96
All other	91	73	83	87	70
Resellers	76	86	140	147	203
All other uses	331	316	342	217	280
Grand total	5,816	4,942	5,165	4,890	5,618

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

DISTRIBUTION BY MAJOR MARKET

(in millions of pounds)

Major Market	1979	1980	1981	1982	1983
Transportation	270	195	177	123	150
Packaging	525	410	424	450	546
Building/Construction	3,167	2,690	2,891	2,902	3,329
Electrical/Electronic	623	539	583	467	386
Furniture & furnishings	320	216	171	236	289
Consumer & Institutional	485	427	434	356	293
Industrial/Machinery	38	16	19	*	20
Adhesives, Inks & Coatings	92	79	56	*	77
All Other	296	370	410	355	528
Exports	322	465	436	566	534
Total	6,138	5,407	5,601	5,455	6,152

*Included in all other.
Source: SPI Committee on Resin Statistics Annual Major Markets Survey.

POLYVINYL CHLORIDE
TYPICAL APPLICATIONS

Food wrap	Pipe	Upholstery
Flooring	Wall covering	Garden hose
Siding	Coatings	Shower curtains

Lawn furniture constructed with corrosion-resistant PVC pipe is an innovative use for plastics. The material is supplied by the B.F. Goodrich Chemical Co.

POLYVINYL ACETATE

There are more than 50 producers of polyvinyl acetate, supplied with monomer by such companies as Borden, Celanese Chemical, DuPont, National Starch, Union Carbide, and U.S. Industrial Chemicals.

SALES AND CAPTIVE USE OF VINYL ACETATE MONOMER FOR POLYVINYL ACETATE
(thousands of pounds)

Year	Emulsion Paint	Adhesives	Paper	Textile	Non-woven Binders	Others	Export	Total
1979	287,617	257,520	87,627	28,935	30,062	46,513	20,782	759,056
1980	224,587	262,431	88,372	33,014	30,991	43,292	18,306	700,993
1981	179,531	263,205	85,465	26,666	29,865	42,357	14,557	641,646
1982	163,470	234,994	94,185	17,250	25,700	26,143	6,081	567,823
1983	210,553	273,751	117,330	22,601	31,212	27,542	5,867	688,856

COMPOUND GROWTH RATE TOTAL SALES & CAPTIVE USE

1978-1983	– 0.6%
1982-1983	21.3%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

POLYVINYL ALCOHOL

The major manufacturers of polyvinyl alcohol in the U.S. are DuPont, Air Products, and Monsanto.

PRODUCTION AND SALES & CAPTIVE USE
(thousands of pounds)

		SALES & CAPTIVE USE		
YEAR	PRODUCTION	DOMESTIC	EXPORT	TOTAL
1979	147,702	123,857	24,451	148,308
1980	140,619	115,177	13,151	128,328
1981	138,898	114,355	20,393	134,748
1982	n.a.	n.a.	n.a.	n.a.
1983	132,176	112,230	23,827	136,057

n.a. = not available.

COMPOUND GROWTH RATE TOTAL SALES & CAPTIVE USE

1978-1983	0.4%
1982-1983	n.a.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

OTHER VINYL RESINS

Producers of these vinyl resins include Dow, DuPont, B.F. Goodrich, W.R. Grace, Monsanto, Morton Industries, Rohm and Haas, Union Carbide and Union Chemical.

PRODUCTION AND SALES & CAPTIVE USE
(thousands of pounds)

YEAR	PRODUCTION	SALES & CAPTIVE USE
1979	220,154	212,779
1980	196,235	192,638
1981	208,201	198,903
1982	177,225	166,695
1983	185,558	177,844

COMPOUND GROWTH RATE OF SALES & CAPTIVE USE	
1978-1983	– 1.4%
1982-1983	6.7%

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney.

MISCELLANEOUS THERMOPLASTICS
(millions of pounds)

PRODUCTION

RESIN	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Acrylics	900	890	773	888	967	1,086	1,142	1,028	1,100	1,131
Cellulosics	225	224	157	n.a.	356	468	480	n.a.	n.a.	n.a.
Petroleum hydrocarbons	297	326	299	306	334	319	321	264	272	283
Non-nylon polyamides	28	48	24	31	41	33	35	46	49	49
Polyterpenes	*	18	11	13	14	15	30	41	36	31
Rosin modifications	139	123	64	64	47	41	94	182	275	388
Other[1]	73	20	63	443	115	169	188	406	607	351

SALES

RESIN	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Acrylics	517	676	n.a	n.a.	n.a.	n.a.	n.a.	n.a.	884	812
Cellulosics	208	199	139	n.a.	228	n.a.	333	n.a.	n.a.	n.a.
Petroleum hydrocarbons	288	310	281	293	332	309	301	253	259	262
Non-nylon polyamides	28	41	23	28	40	33	34	42	47	44
Polyterpenes	*	19	10	13	14	15	30	36	35	29
Rosin modifications	126	109	50	63	47	42	85	177	266	325
Other[1]	66	82	727	1,043	862	883	667	791	806	280

n.a. = not available
*Included in other

[1]Includes acrylic (sales only 1975-1980), chlorinated polyolefins, coumarone-indene, fluoropolymers, polybutylene, polyphenyl aromatic esters, and other thermoplastics. Cellulosics also included in 1978, 1980 & 1982. Thermoplastic polyesters were taken out in 1982.
Source: *Synthetic Organic Chemicals*, U.S. International Trade Commission.

DOMESTIC SALES & USE OF SELECTED THERMOPLASTICS BY PROCESS GRADE

(millions of pounds)

MATERIAL/YEAR	TOTAL	INJECTION MOLDING	EXTRUSION	BLOW MOLDING	OTHER
Grand Total					
1979	25,443	6,010	13,143	1,928	4,362
1980	23,102	5,218	11,636	2,134	4,114
1981	24,232	5,383	12,252	2,293	4,304
1982	23,259	4,979	11,665	2,383	4,232
1983	26,546	5,615	13,392	2,620	4,919
Growth Rate 1978-1983	2.6%	1.0%	2.0%	9.4%	3.2%
LD Polyethylene					
1979	6,917	650	5,465	60	742
1980	6,320	519	4,952	65	784
1981	6,533	524	5,087	60	862
1982	6,543	507	5,118	42	876
1983	7,127	657	5,628	42	800
Growth Rate 1978-1983	2.2%	1.8%	2.2%	– 5.6%	3.3%
HD Polyethylene					
1979	4,285	1,074	853	1,724	634
1980	3,867	938	783	1,573	573
1981	4,222	997	903	1,696	626
1982	4,347	1,102	898	1,714	633
1983	4,706	1,188	1,076	1,808	634
Growth Rate 1978-1983	5.1%	8.2%	7.1%	4.4%	– 0.4%
Polypropylene					
1979	3,180	1,219	1,430	62	469
1980	3,035	1,119	1,381	63	472
1981	3,202	1,243	1,473	65	421
1982	2,885	1,073	1,268	68	476
1983	3,664	1,232	1,724	90	618
Growth Rate 1978-1983	6.4%	3.0%	7.5%	8.8%	10.8%
A B S[a]					
1979	1,124	586	302	—	236
1980	859	471	208	—	180
1981	848	488	180	—	180
1982	689	430	111	—	148
1983	900	560	145	—	195
Growth Rate 1978-1983	– 3.6%	2.4%	– 16.5%	—	– 3.0%

[a]ABS estimated in 1983.

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney. Industry contacts.

DOMESTIC SALES & USE OF SELECTED THERMOPLASTICS BY PROCESS GRADE (Cont'd.)

(millions of pounds)

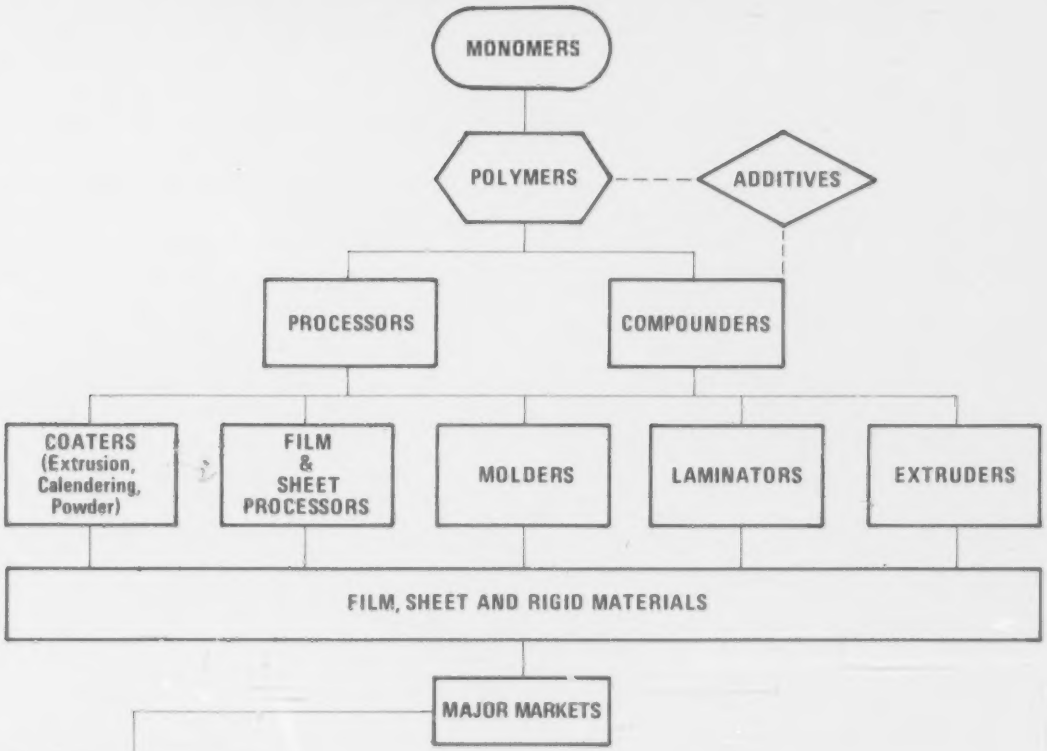
MATERIAL/YEAR	TOTAL	INJECTION MOLDING	EXTRUSION	BLOW MOLDING	OTHER
Polystyrene					
1979	3,836	1,901	1,314	—	621
1980	3,350	1,596	1,083	—	671
1981	3,453	1,638	1,142	—	673
1982	3,105	1,368	1,060	—	677
1983	3,529	1,516	1,238	—	775
Growth Rate					
1978-1983	– 1.1%	– 3.5%	– 0.1%	—	3.5%
Nylon					
1979	285	195	67	—	23
1980	248	169	74	—	5
1981	270	178	76	—	16
1982	229	138	71	—	20
1983	305	198	85	—	22
Growth Rate					
1978-1983	3.5%	2.0%	8.3%	—	1.0%
Thermoplastic Polyester					
1979	n.a.	n.a.	n.a.	n.a.	n.a.
1980	481	140	5	335	1
1981	539	150	7	380	2
1982	571	100	10	456	5
1983	697	n.a.	n.a.	514	183
Growth Rate					
1978-1983	n.a.	n.a.	n.a.	n.a.	n.a.
P V C					
1979	5,816	421	3,514	82	1,799
1980	4,942	317	2,978	98	1,549
1981	5,165	280	3,149	92	1,644
1982	4,890	261	3,129	103	1,397
1983	5,618	264	3,496	166	1,692
Growth Rate					
1978-1983	0.2%	– 9.7%	1.4%	12.0%	– 1.0%

n.a. = not available

Source: Monthly Statistical Report, SPI Committee on Resin Statistics, as compiled by Ernst & Whinney. Industry contacts.

FABRICATED PLASTIC PRODUCTS

FLOW CHART: FROM RAW MATERIAL TO FINAL PRODUCT



Transportation	Automotive, Aircraft, Marine, Railroad, Aerospace, Recreational, Military
Packaging	Containers, Closures, Shipping Products, Coatings, Flexible Packaging
Building/Construction	Pipe & Fittings, Plumbing & Bathroom Fixtures, Interior/Exterior Building Materials, Air Supported Structures
Electrical/Electronic	Appliance, Communications, Business Machines, Records, Tape, Batteries
Furniture/Furnishings	Carpets & Rugs, Wall Coverings, Bedding, House Furnishings
Consumer/Institutional	Luggage, Cutlery, Lawn & Garden, Medical & Healthcare, Toys & Sporting Goods, Graphic Arts, Laboratory Supplies, Footwear
Industrial/Machinery	Signs & Displays, Ordnance, Farm & Construction Equipment, Machine Tools, Marine Supplies, Engine Parts
Other	Adhesives, Inks, Coatings
Exports	

Source: SPI, Committee on Resin Statistics, *Major Markets Manual*.

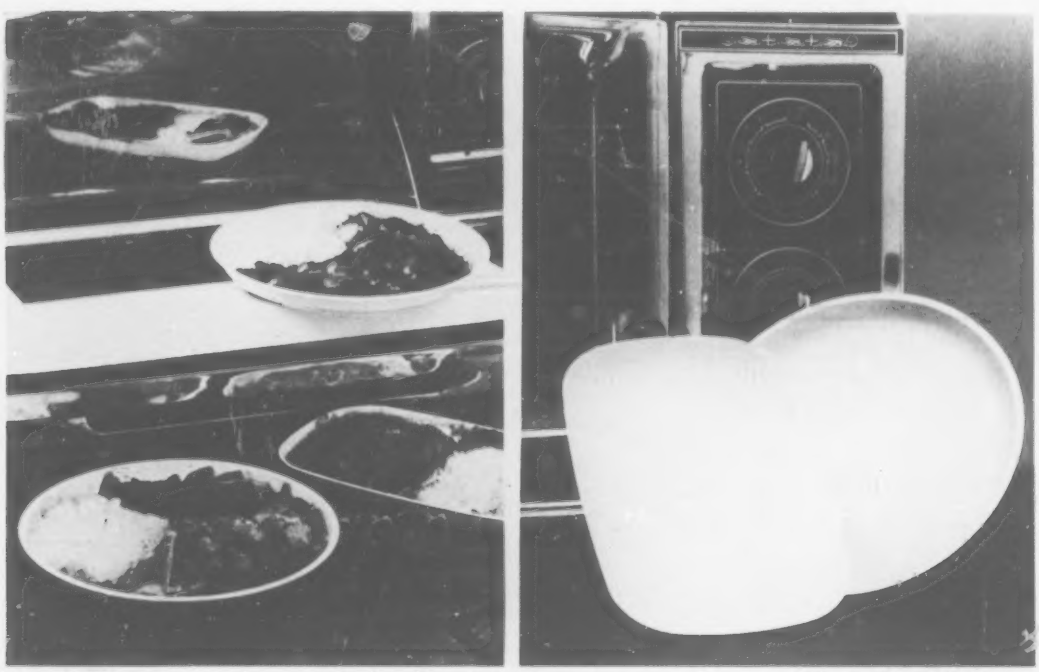
REINFORCED PLASTICS SHIPMENTS BY MARKET

(BOTH THERMOSET & THERMOPLASTIC RESINS)

	SHIPMENTS (in millions of pounds)					
MARKETS	**1979**	**1980**	**1981**	**1982**	**1983[1]**	**1984[2]**
Aircraft & Aerospace	23	25	28	22	25	29
Appliances & Equipment	130	104	117	82	106	123
Construction	335	287	317	312	400	422
Consumer Goods	126	103	115	84	128	143
Corrosion-Resistant Products	238	252	275	235	288	320
Electrical Rods, Tubes, Parts	190	162	178	140	170	189
Marine & Marine Accessories	385	275	290	230	276	309
Land Transportation	550	416	445	359	458	540
Miscellaneous	79	70	75	64	72	80
Total	2,056	1,694	1,840	1,528	1,923	2,155

[1] = estimate
[2] = forecast

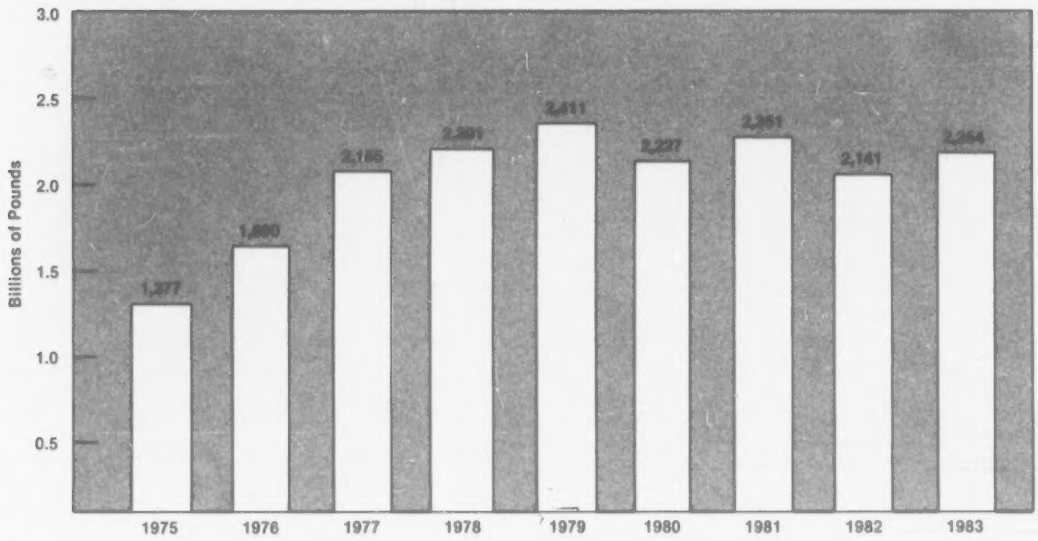
Source: Reinforced Plastics/Composites Institute, SPI.



Disposable microwave cookware made of reinforced polyester resin. *Courtesy of Plastics World Magazine*

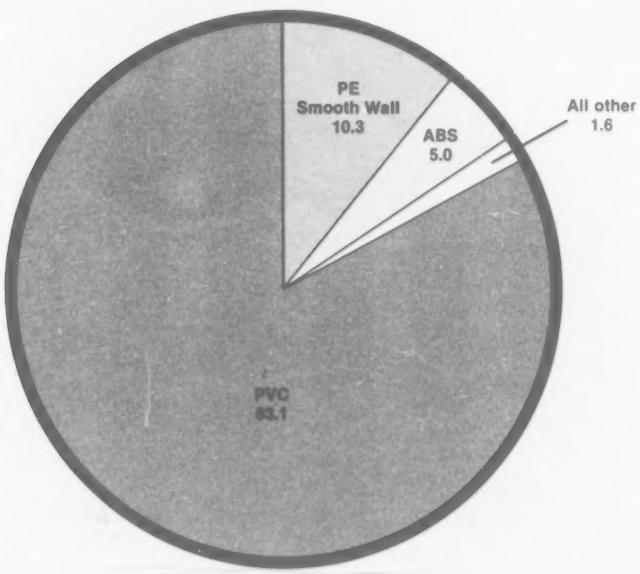
PLASTICS PIPE AND FITTINGS

U.S. PLASTICS PIPE AND FITTINGS SHIPMENTS 1975-1983



Source: SPI Monthly Thermoplastics Pipe & Fittings Report, as compiled by Ernst & Whinney.

SHIPMENTS BY MATERIAL—1983



U.S. SHIPMENTS OF THERMOPLASTIC PIPE, TUBE & CONDUIT BY MATERIAL

(in millions of pounds)

YEAR	TOTAL	PVC	ABS	PE[1]	OTHER
1979	2,254	1,860	185	197	12
1980	2,085	1,713	125	235	12
1981	2,202	1,834	97	256	15
1982	2,002	1,719	71	197	15
1983	2,068	1,731	88	232	17
Growth Rate 1978-1983	−0.4%	−0.4%	−13.3%	8.3%	5.5%

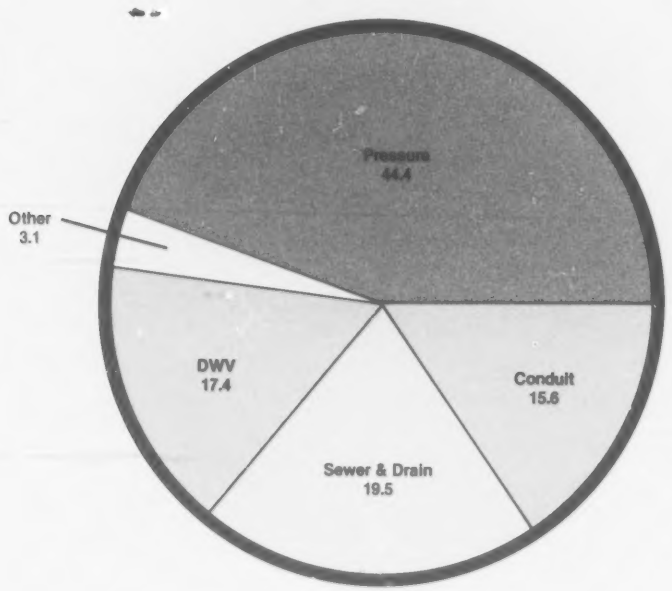
[1]Excludes corrugated

U.S. PLASTIC PIPE SHIPMENTS BY MATERIAL 1983 vs 1982

(in millions of pounds)

MATERIAL	1983	1982	CHANGE	% CHANGE
PVC	1,731	1,719	12	0.7%
ABS	88	71	17	23.9
PE (Smooth wall)	232	197	35	17.8
Other	17	15	2	13.3
Total	2,068	2,002	66	3.3%

DISTRIBUTION OF PLASTICS PIPE SHIPMENTS BY APPLICATION—1983



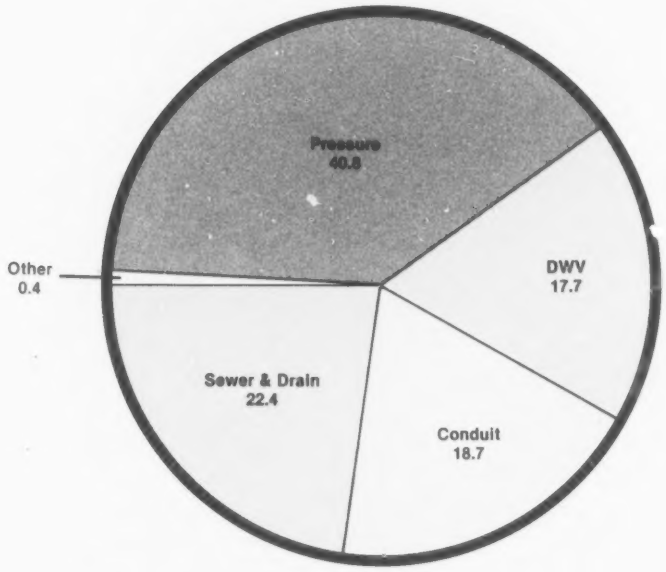
U.S. SHIPMENTS OF THERMOPLASTIC PIPE, TUBE & CONDUIT BY APPLICATION

(in millions of pounds)

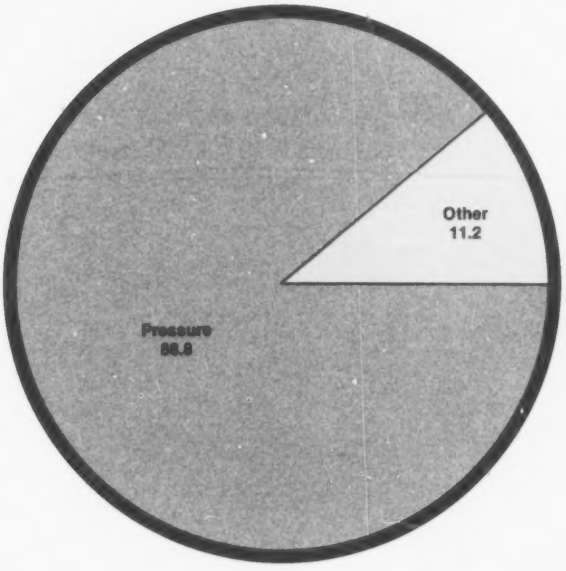
YEAR	TOTAL	PRESSURE	CONDUIT	DWV	SEWER & DRAIN	OTHER
1979	2,254	1,058	406	313	362	115
1980	2,085	1,048	370	289	299	79
1981	2,202	1,130	370	289	333	80
1982	2,002	980	318	314	335	55
1983	2,068	919	323	359	403	64
Growth Rate 1978-1983	– 0.4%	– 0.9%	– 2.0%	1.8%	3.7%	– 13.1%

DWV = Drain, Waste & Vent

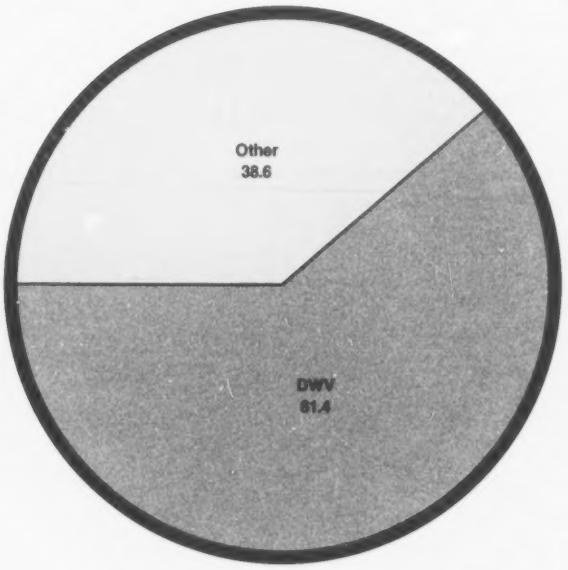
DISTRIBUTION OF PVC PIPE SHIPMENTS BY APPLICATION—1983



DISTRIBUTION OF POLYETHYLENE PIPE SHIPMENTS BY APPLICATION—1983



DISTRIBUTION OF ABS PIPE SHIPMENTS BY APPLICATION—1983

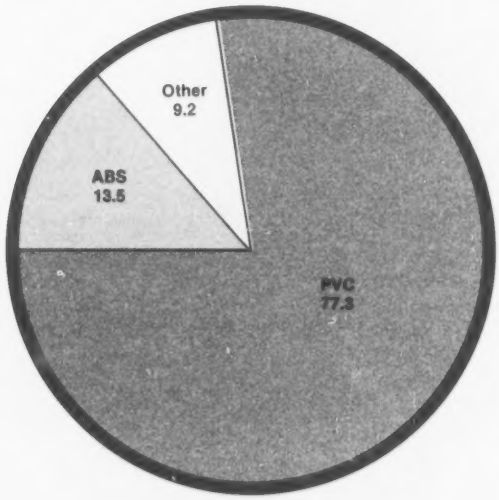


U.S. PLASTICS FITTINGS BY APPLICATION

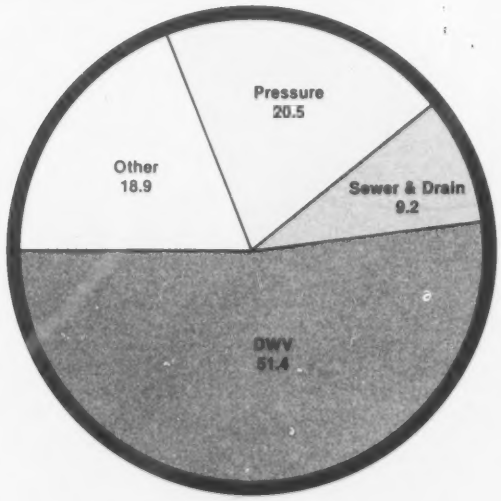
(in millions of pounds)

YEAR	TOTAL	PRESSURE	DWV	OTHER NON-PRESSURE
1979	157	36	81	40
1980	142	34	68	40
1981	149	38	69	42
1982	140	37	67	36
1983	185	38	95	52
Growth Rate 1978-1983	– 0.2%	3.5%	– 4.1%	6.5%

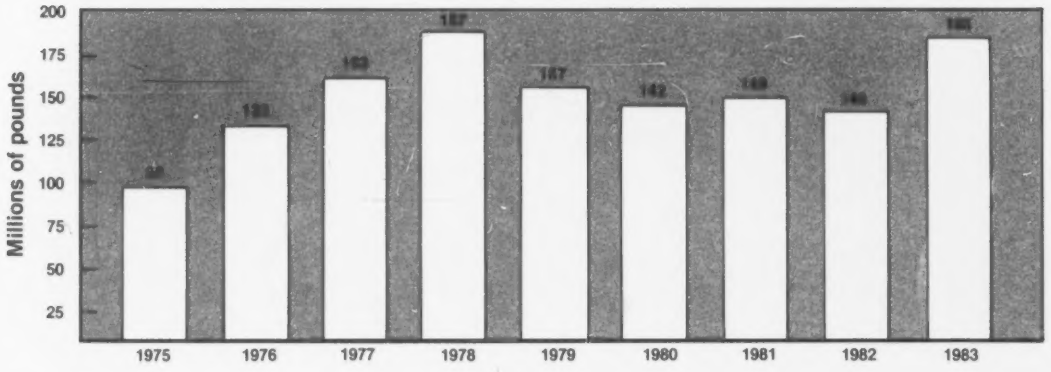
DISTRIBUTION OF PLASTICS FITTINGS BY MATERIAL-1983



DISTRIBUTION OF PLASTICS FITTINGS BY APPLICATION—1983



U.S. PLASTICS FITTINGS SHIPMENTS: 1975-1983



Source: SPI Monthly Thermoplastic Pipe & Fittings Report, as compiled by Ernst & Whinney.

U.S. PLASTICS FITTINGS SHIPMENTS BY MATERIAL

(millions of pounds)

Year	Total	PVC	ABS	Other*
1979	157	109	38	10
1980	142	103	30	9
1981	149	113	26	10
1982	140	112	19	9
1983	185	143	25	17
Growth Rate 1978-1983	– 0.2%	3.9%	– 15.8%	11.2%

*Includes polyethylene, chlorinated PVC, polyacetal, etc.

MAJOR MARKETS

DEFINITIONS

The primary product groups for each Major Market category are listed below:

A. TRANSPORTATION

Motor Vehicles and Parts: including autos, trucks, buses, motorcycles, and bicycles. Ships, boats and recreational vehicles.

All Other: including railroad equipment, travel trailers, campers, golf carts, snowmobiles, aircraft, military vehicles.

B. PACKAGING

Bottles, Jars, Vials

Food Containers: including disposable cups

Blister and Bubble Containers

Flexible Packaging: including household and institutional refuse bags and film

All Other: including tubes, tape, strapping, drums, caps, baskets, trays, boxes. pallets, shipping crates, pails, buckets, shipping cases.

C. BUILDING AND CONSTRUCTION

Pipe, Conduit and Fittings: including drainage, irrigation, plumbing fixtures, septic tanks

Building Material for all Structures: including siding, flooring, and insulation materials

All Other: including panels, doors, windows, skylights, bathroom units, gratings and railings.

D. ELECTRICAL AND ELECTRONIC

Home and Industrial Appliances: including electrical industrial equipment, wire and cable coverings, communications equipment

Electronic Components: including resistors, magnetic tape, records, and batteries.

E. FURNITURE AND FURNISHINGS

Rigid and Flexible Types: including household and office furniture, bedding, carpets, rugs, backing, curtains, blinds, awnings, lamps, picture frames, wall coverings.

F. CONSUMER AND INSTITUTIONAL PRODUCTS

Dinner and Kitchenware: including picnicware

Toys and Sporting Goods

Health Care and Medical Products: including laboratory supplies

Hobby and Graphic Arts Supplies: including photographic equipment and supplies

All Other: including footwear, luggage, buttons, lawn & garden tools, signs and displays, credit cards.

G. INDUSTRIAL/ MACHINERY

All Types: including engine and turbine parts, farm and garden machinery, construction and related equipment, machine tools, ordnance and firearms, chemical process equipment.

H. ADHESIVES/INKS/COATINGS

Adhesives and Sealants

All Other: including printing ink, magnet wire enamels, core binders, foundry facings, paper coating and glazing, paints, varnishes, and enamels.

I. RESELLERS/COMPOUNDERS

Sales of Resins Sold to Resellers, Compounders, Converters.

Unclassified Sales: including calenderers whose end-use markets cannot be ascertained by the resin supplier, or resin that cannot be classified under any of the Major Market categories listed above.

J. EXPORTS

Sales of Plastic Resin exported from the U.S.

1983 RESULTS

The 1983 data reflect major market plastics resins sales and captive use data compiled by Ernst & Whinney with consumption data being reported by individual resin. The plastics resins categories included in this study are:

THERMOSETS

Epoxy
Polyester, Unsaturated
Urea and Melamine
Phenolic
All Other Thermosets

THERMOPLASTICS

Low Density Polyethylene
High Density Polyethylene
Polypropylene
Acrylonitrile-Butadiene-Styrene (ABS) and Styrene-Acrylonitrile (SAN)
Polystyrene
Styrene Butadiene Latexes (SBL), and Other Styrene Based Latexes (OSBL), and Other Styrene Based Polymers (OSBP)
Nylon
Polyvinyl Chloride
Thermoplastic Polyester
All Other Thermoplastics

In addition, sales and captive use of polyurethane are reported separately by Major Market total only in an appendix to this report.

COMPARISON OF 1983 DATA TO PRIOR YEARS
FIVE YEAR COMPARISON OF RESIN SALES & USE BY MAJOR MARKET*

(millions of pounds, dry weight basis)

MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	1,934	1,605	1,573	1,392	1,896
Packaging	10,334	10,003	10,465	10,497	11,813
Building/Construction	7,573	6,424	7,259	7,154	8,552
Electrical/Electronic	3,043	2,453	2,670	2,275	2,514
Furniture/Furnishings	1,894	1,646	1,670	1,556	2,007
Consumer & Institutional	3,753	3,553	3,670	3,269	3,816
Industrial/Machinery	517	391	393	241	318
Adhesives, Inks & Coatings	2,794	2,387	2,572	1,584	1,800
All Other	3,443	3,054	3,259	3,232	3,636
Exports	3,432	3,670	3,425	3,909	4,150
Total	38,717	35,186	36,956	35,109	40,502

*Note: All figures exclude polyurethane

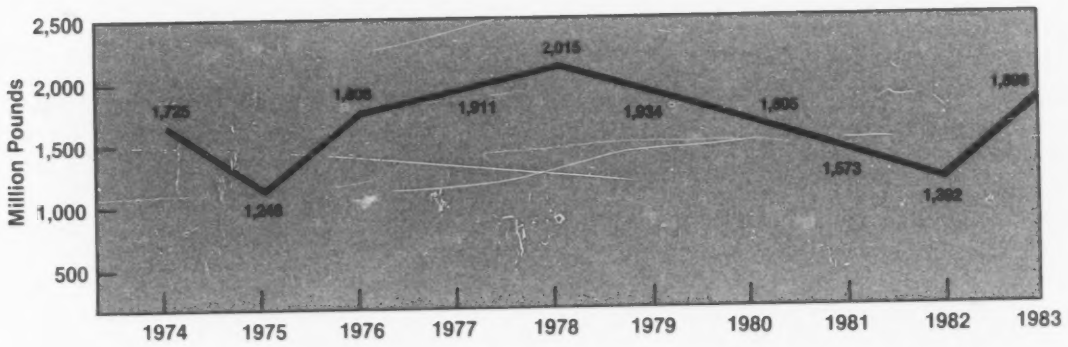
COMPARATIVE PERCENTAGE DISTRIBUTION BY MAJOR MARKET

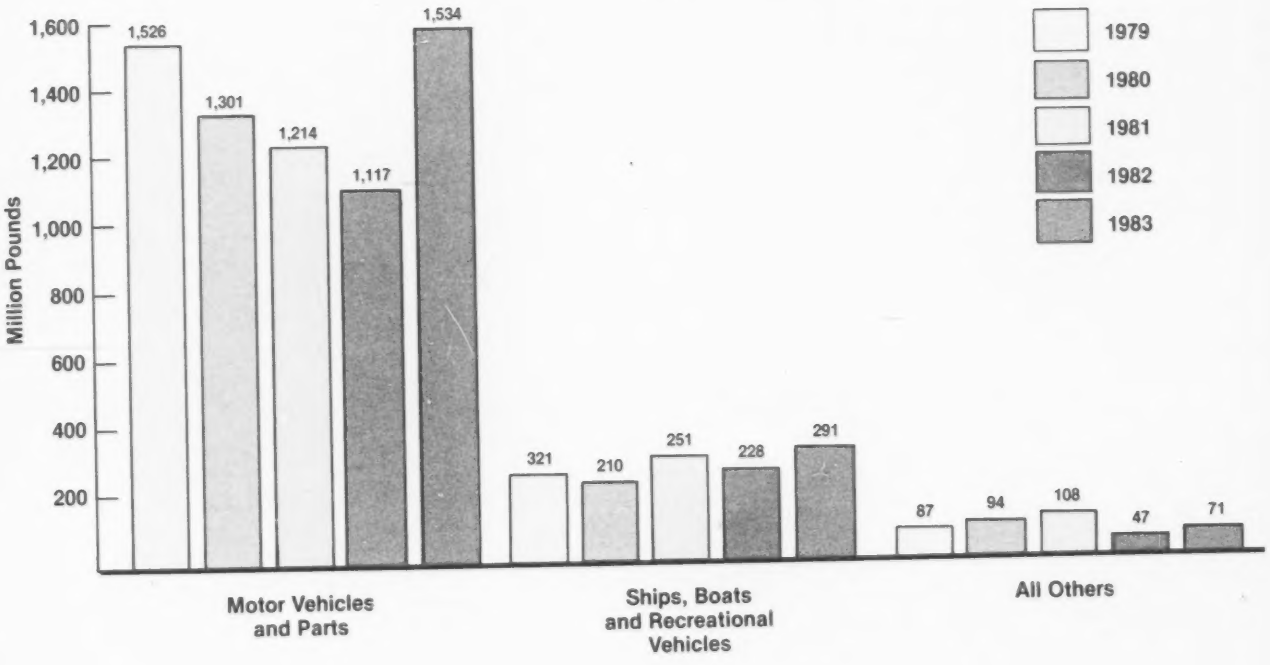
MAJOR MARKET	1979	1980	1981	1982	1983
Transportation	5.0%	4.6%	4.3%	4.0%	4.7%
Packaging	26.7	28.4	28.3	29.9	29.2
Building/Construction	19.6	18.3	19.6	20.4	21.1
Electrical/Electronic	7.9	7.0	7.2	6.5	6.2
Furniture/Furnishings	4.9	4.7	4.5	4.4	5.0
Consumer & Institutional	9.7	10.1	9.9	9.3	9.4
Industrial/Machinery	1.3	1.1	1.1	0.7	0.8
Adhesives, Inks & Coatings	7.2	6.8	7.0	4.5	4.4
All Other	8.9	8.6	8.8	9.2	9.0
Exports	8.8	10.4	9.3	11.1	10.2
Total	100.0%	100.0%	100.0%	100.0%	100.0%

PERCENTAGE CHANGE IN SALES AND USE BY MAJOR MARKET

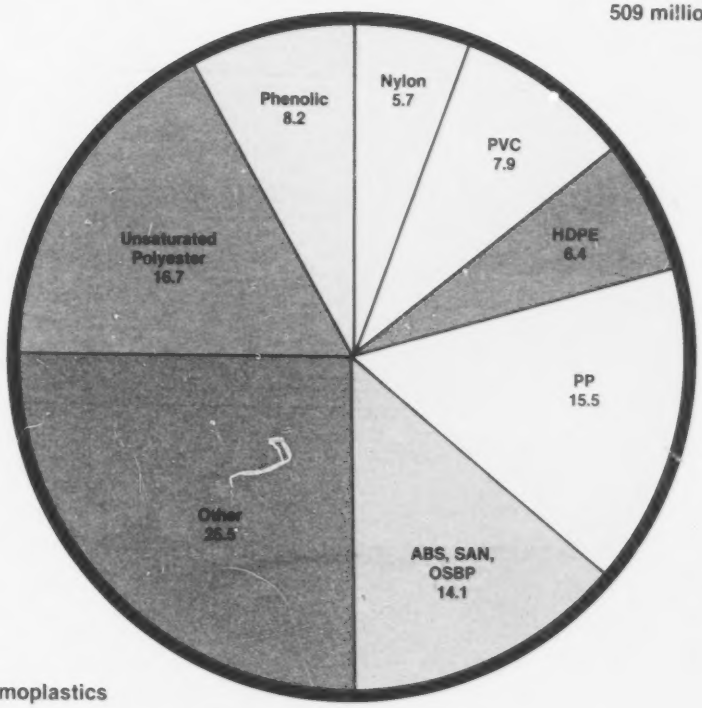
MAJOR MARKET	% CHANGE 1983/1982	% CHANGE 1982/1981	GROWTH RATE 1978-1983
Transportation	36.2%	– 11.5%	– 1.2%
Packaging	12.5	0.3	5.5
Building/Construction	19.5	– 1.4	4.2
Electrical/Electronic	10.5	– 14.8	– 3.1
Furniture/Furnishings	29.0	– 6.8	3.5
Consumer/Institutional	16.7	– 10.9	1.2
Industrial/Machinery	32.0	– 38.7	– 3.5
Adhesives/Inks/Coatings	13.6	– 38.4	– 9.1
All Other	12.5	– 0.8	4.3
Exports	6.2	14.1	9.9
Total	15.4%	– 5.0%	2.9%

TRANSPORTATION



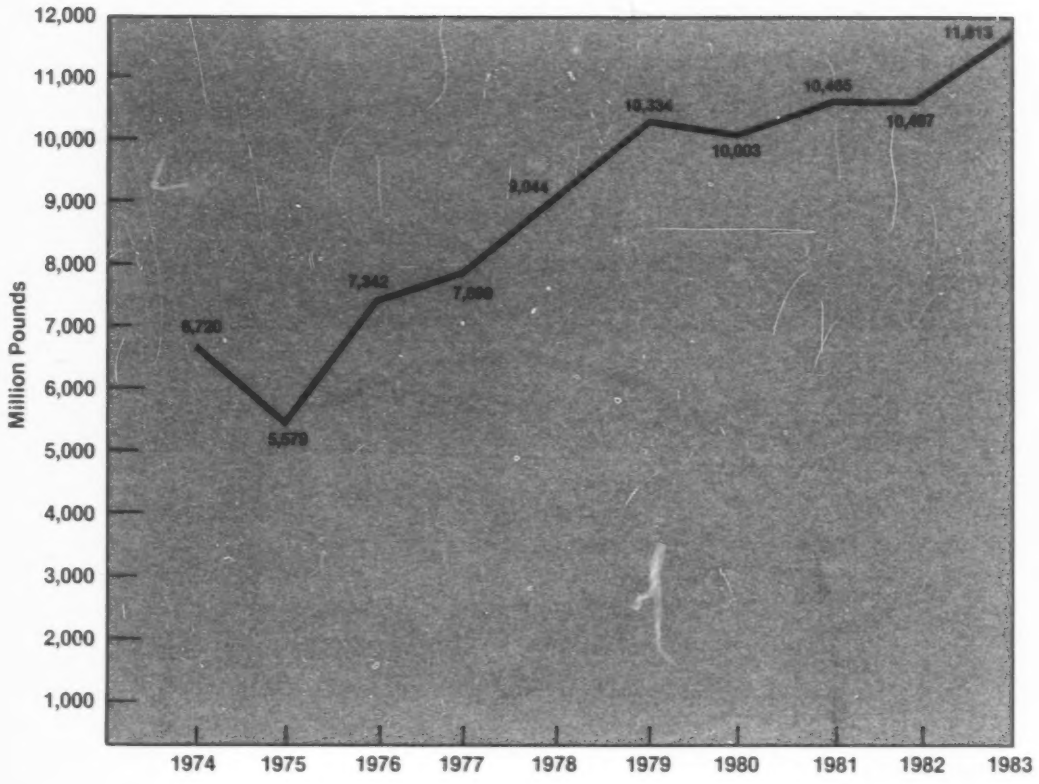


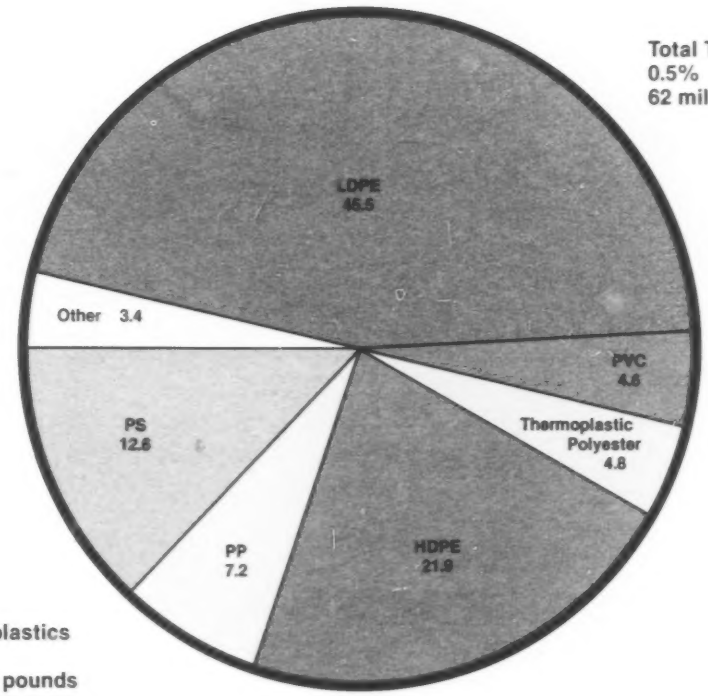
Total Thermosets
26.8%
509 million pounds



Total Thermoplastics
73.2%
1,387 million pounds

PACKAGING

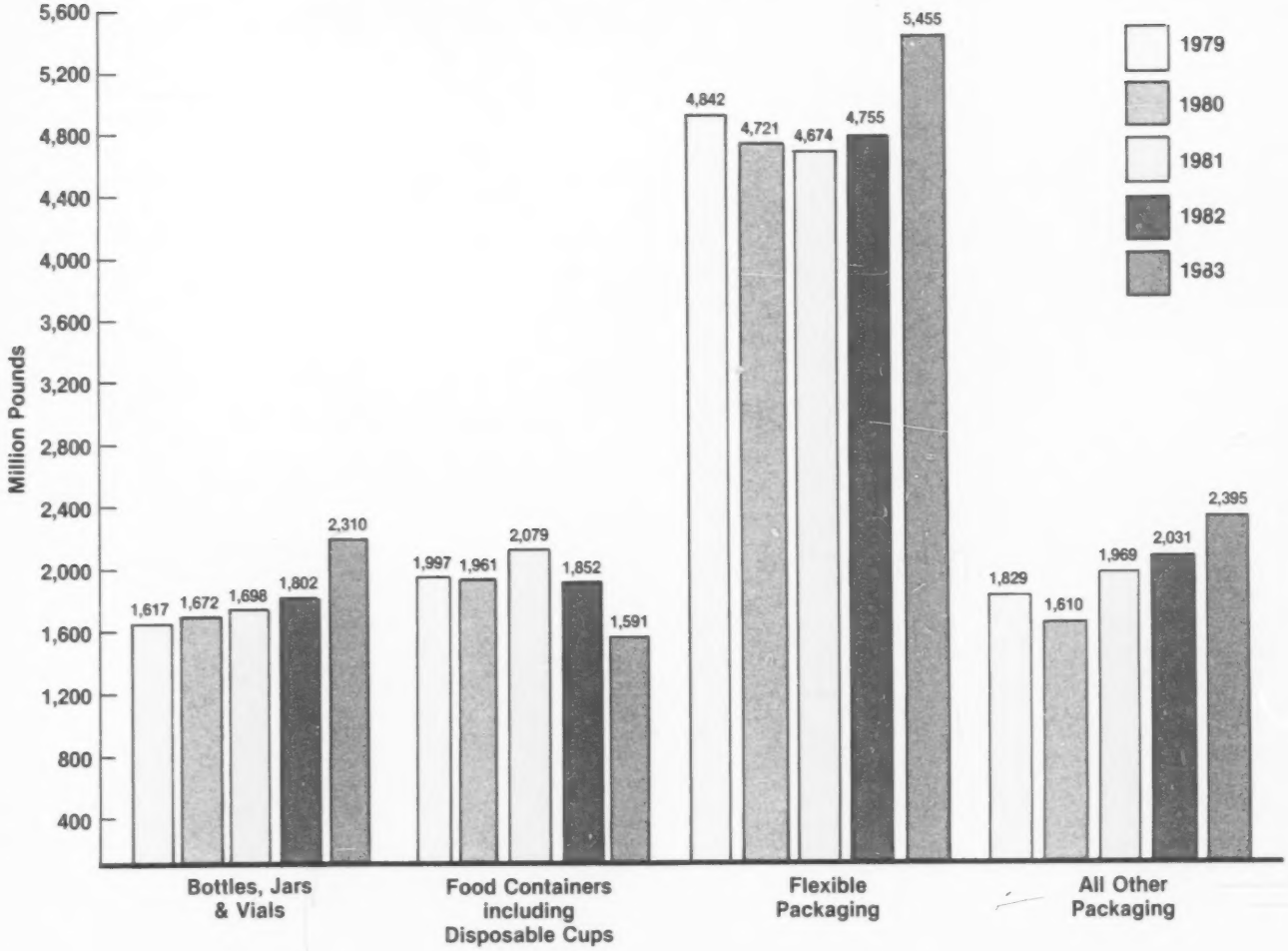




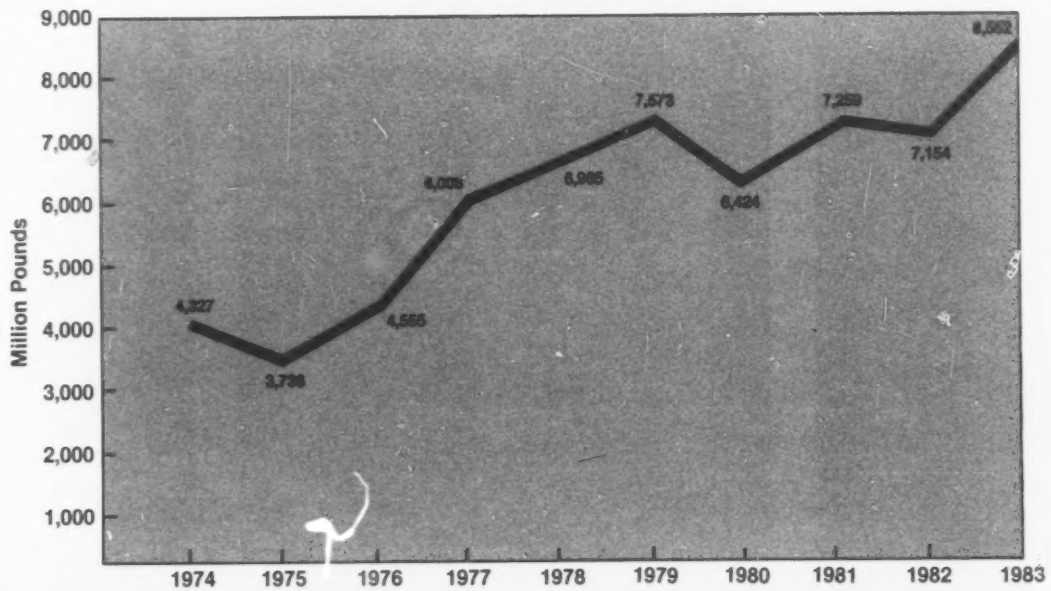
Total Thermosets
0.5%
62 million pounds

Total Thermoplastics
99.5%
11,751 million pounds

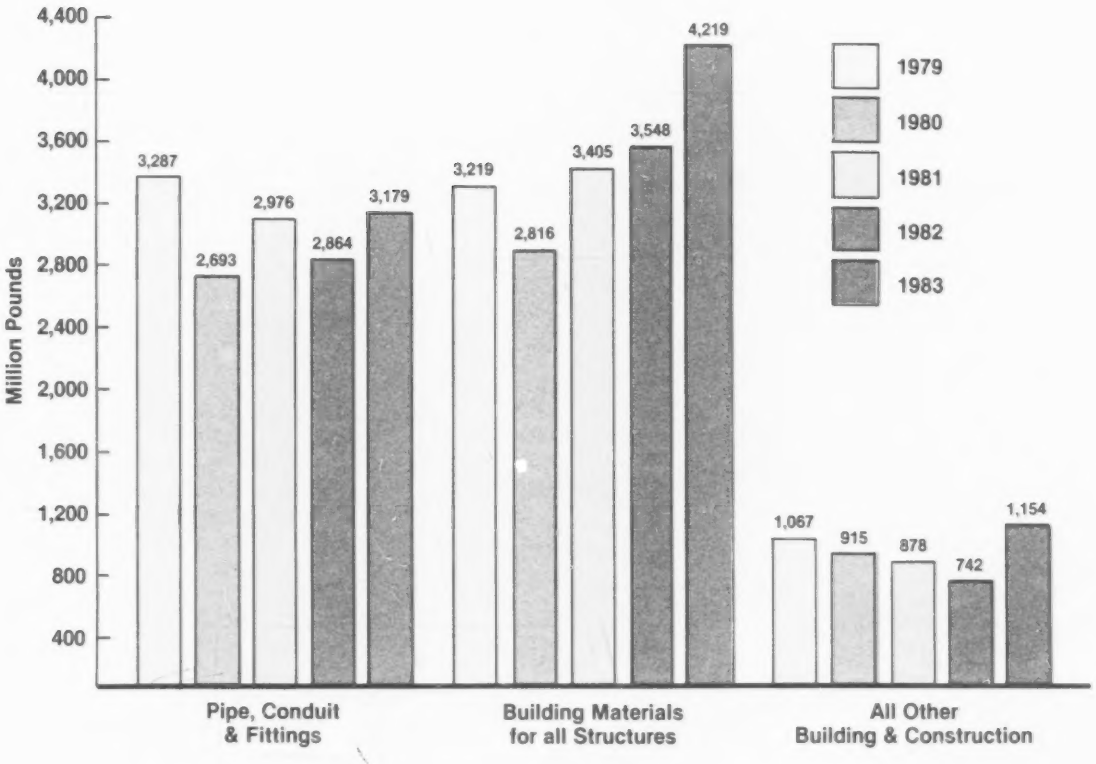
PACKAGING — THERMOPLASTIC DISTRIBUTION

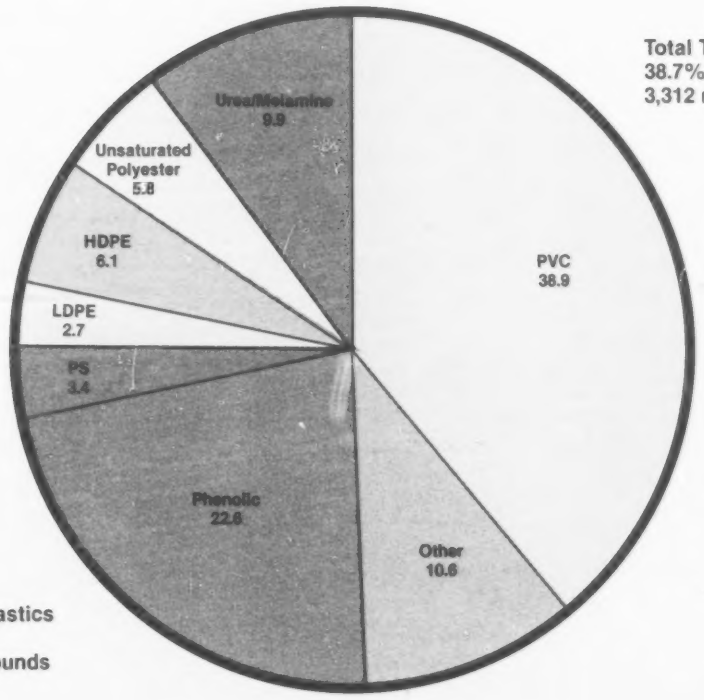


BUILDING AND CONSTRUCTION



BUILDING AND CONSTRUCTION (cont'd.)

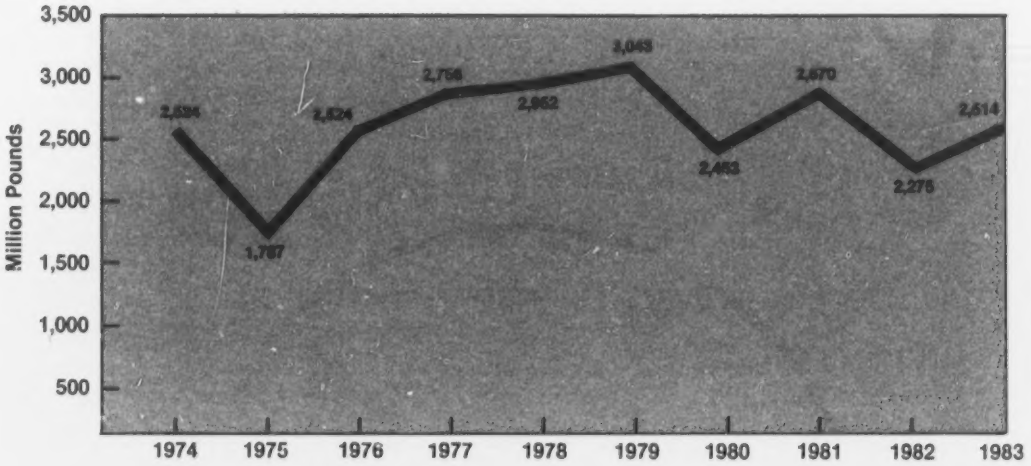


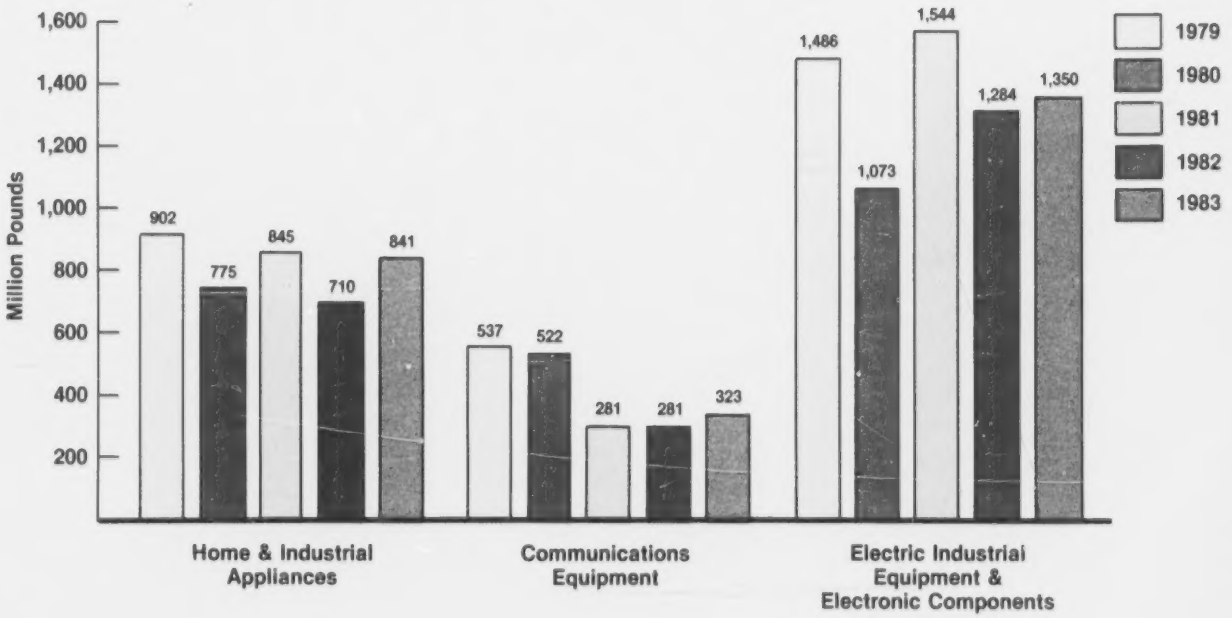


Total Thermosets
38.7%
3,312 million pounds

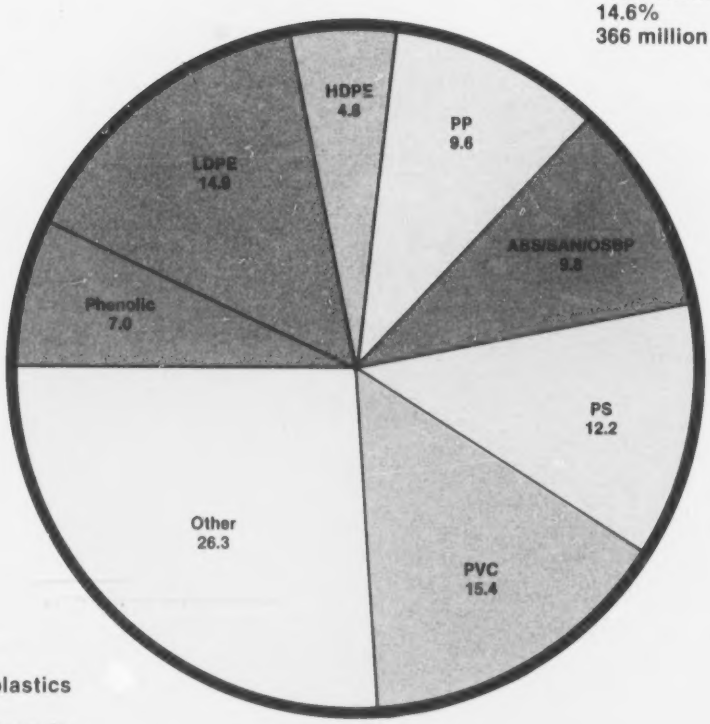
Total Thermoplastics
61.3%
5,240 million pounds

ELECTRICAL AND ELECTRONIC





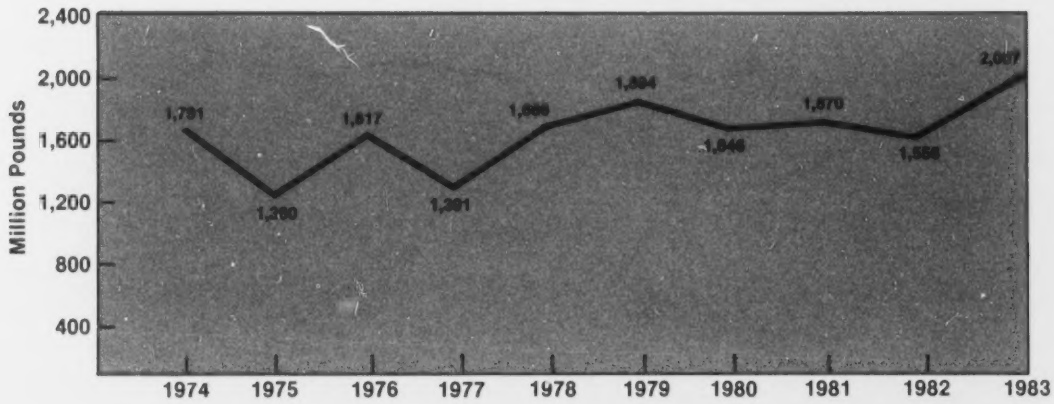
ELECTRICAL AND ELECTRONIC (cont'd.)

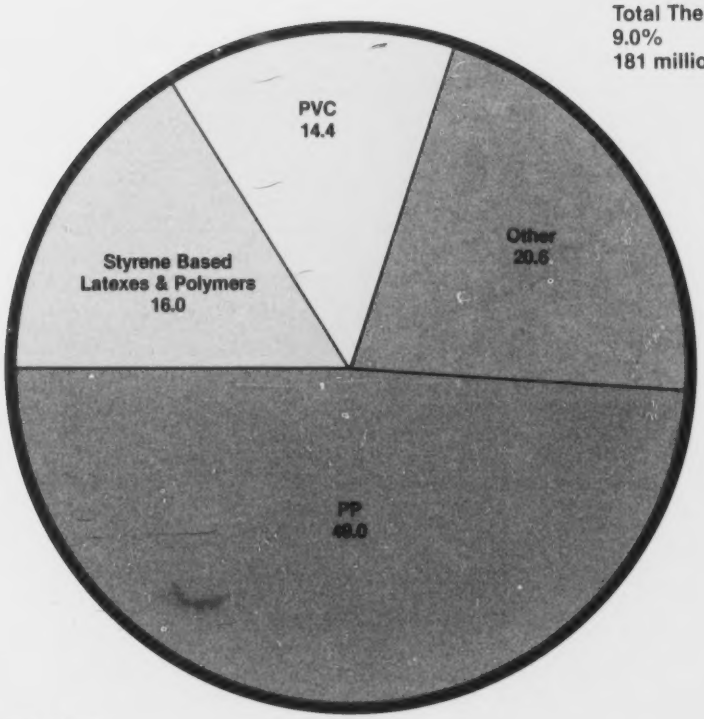


Total Thermosets
14.6%
366 million pounds

Total Thermoplastics
85.4%
2,148 million pounds

FURNITURE AND FURNISHINGS

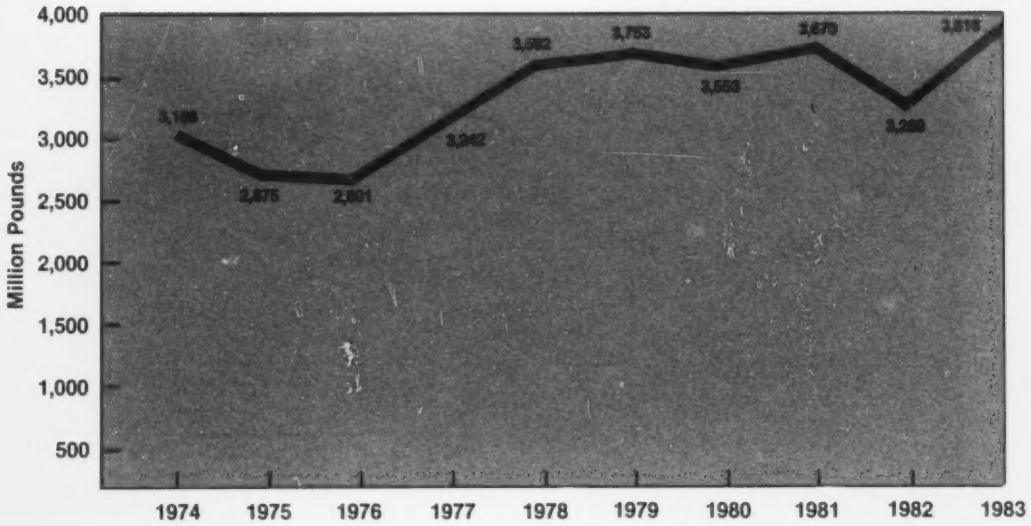


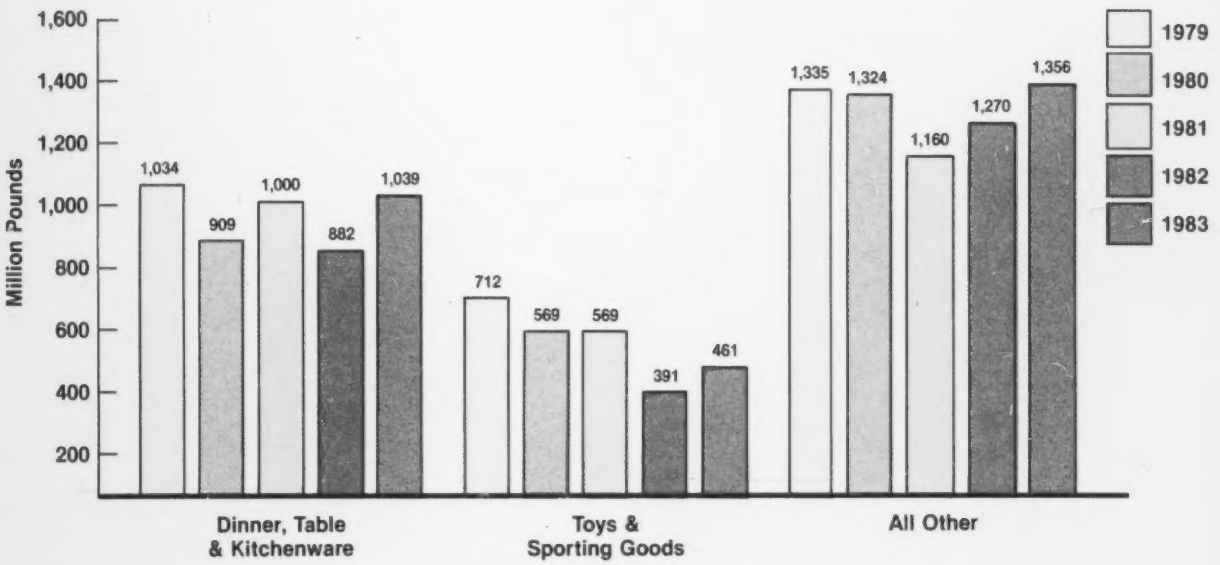


Total Thermosets
9.0%
181 million pounds

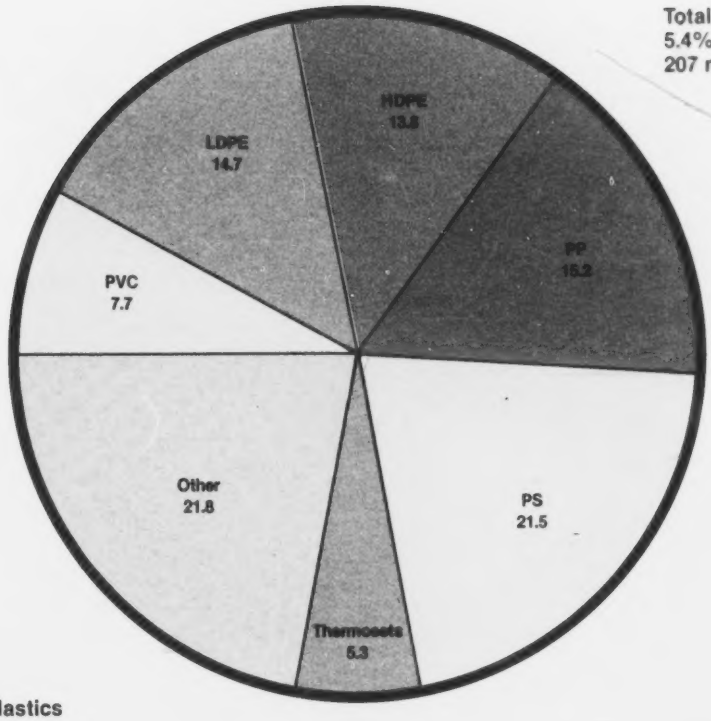
Total Thermoplastics
91.0%
1,826 million pounds

CONSUMER AND INSTITUTIONAL





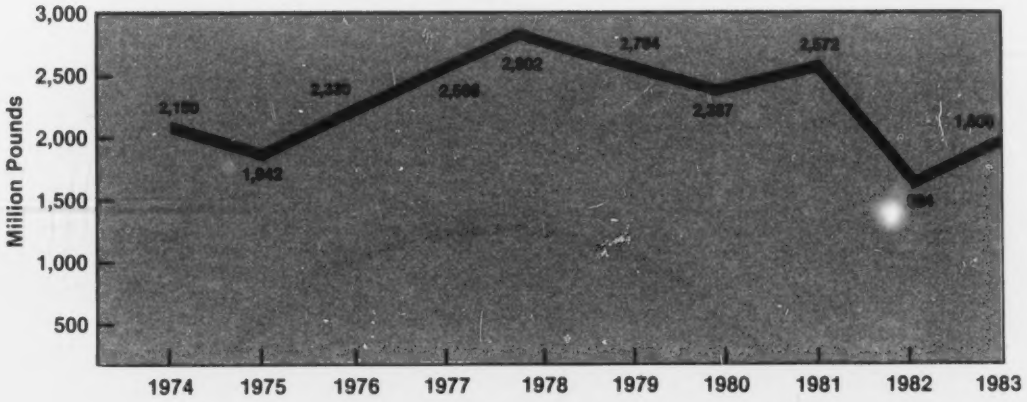
CONSUMER AND INSTITUTIONAL (cont'd.)

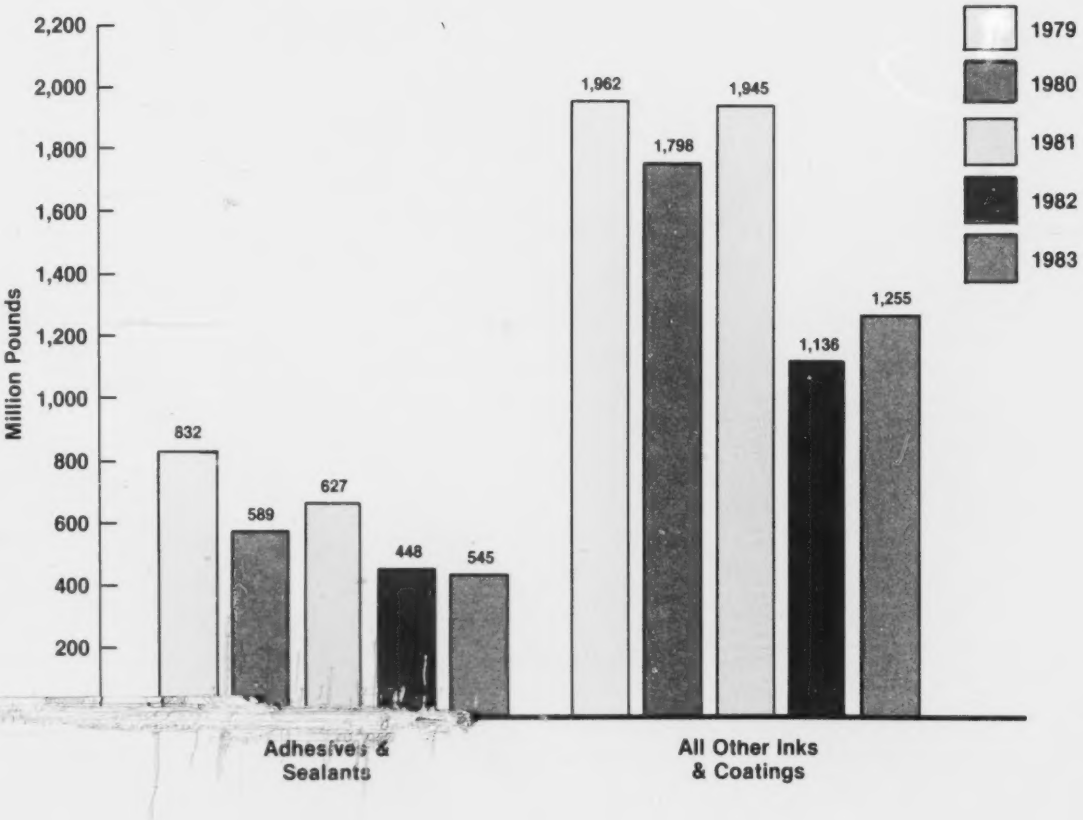


Total Thermosets
5.4%
207 million pounds

Total Thermoplastics
94.6%
3,609 million pounds

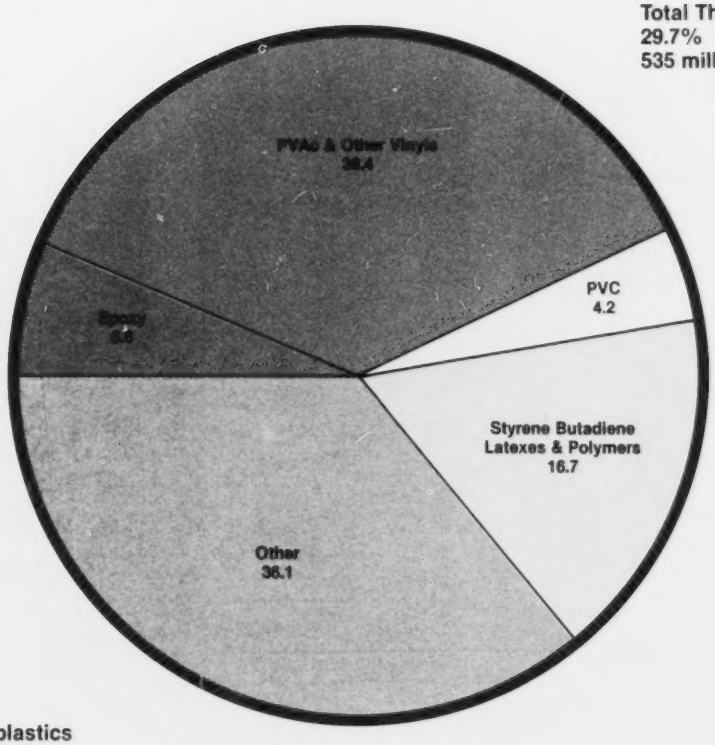
ADHESIVES/INKS/COATINGS





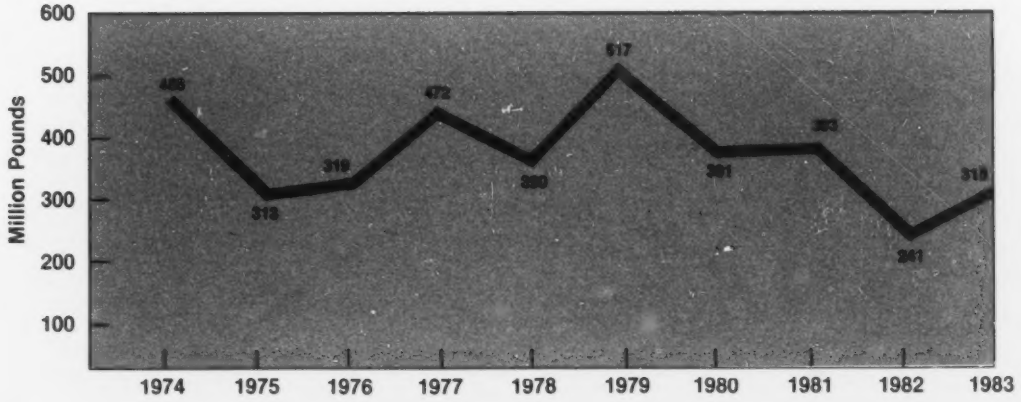
ADHESIVES/INKS/COATINGS (cont'd.)

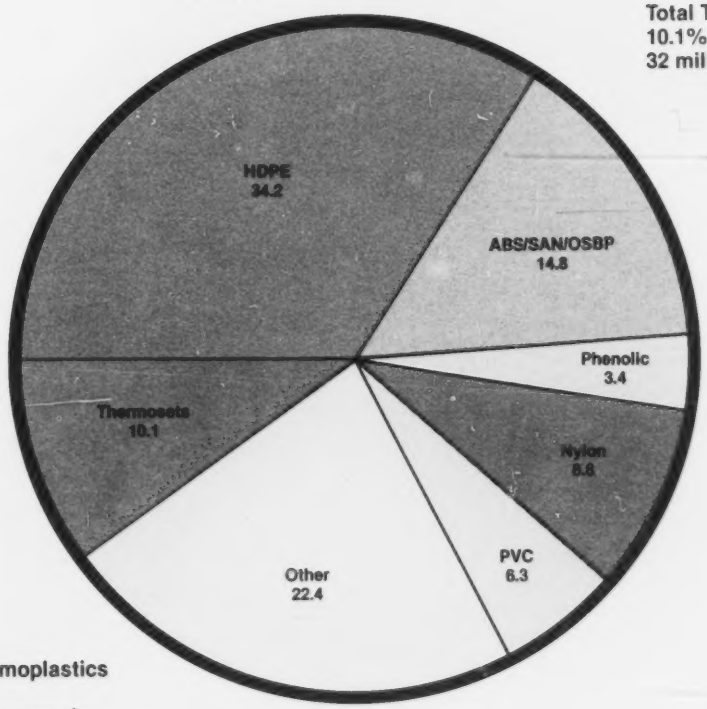
Total Thermosets
29.7%
535 million pounds



Total Thermoplastics
70.3%
1,265 million pounds

INDUSTRIAL/MACHINERY

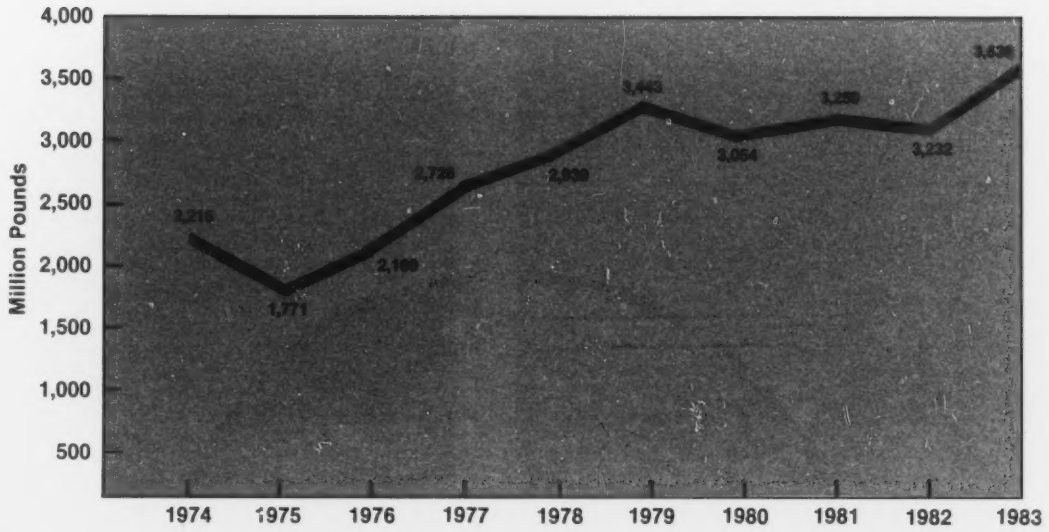


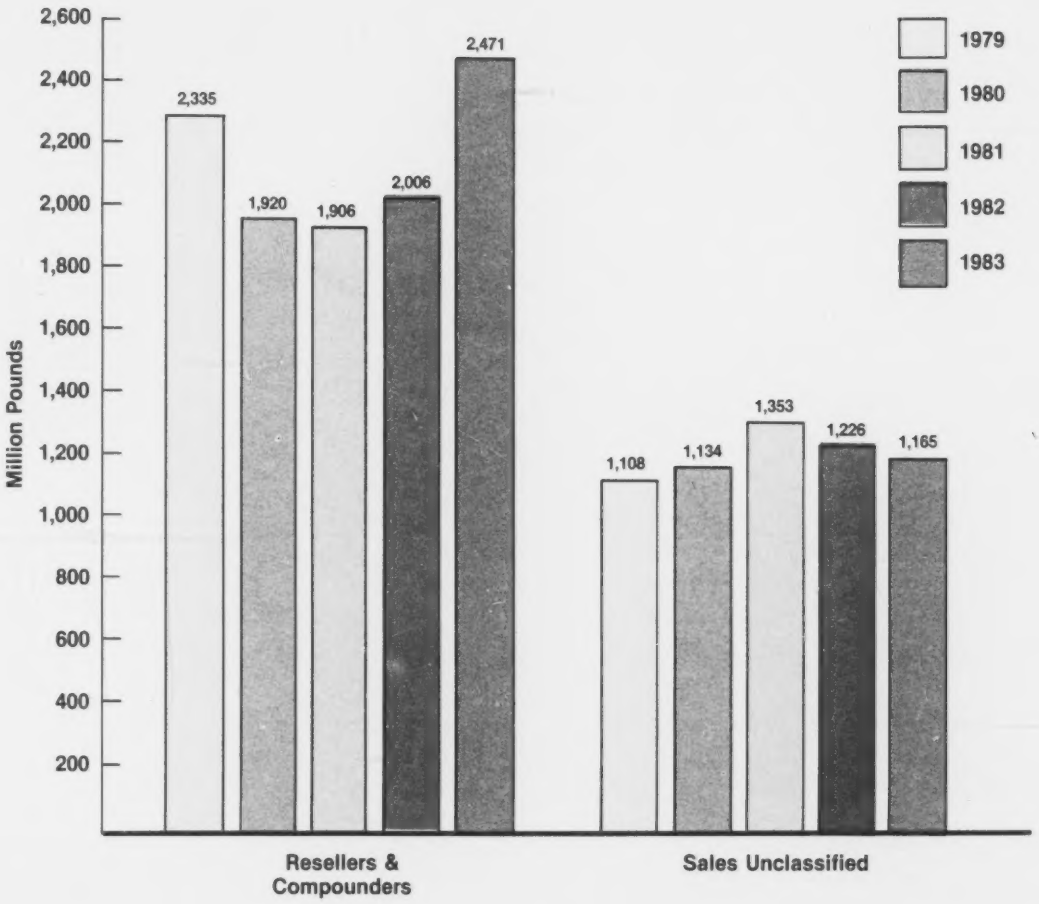


Total Thermosets
10.1%
32 million pounds

Total Thermoplastics
89.9%
286 million pounds

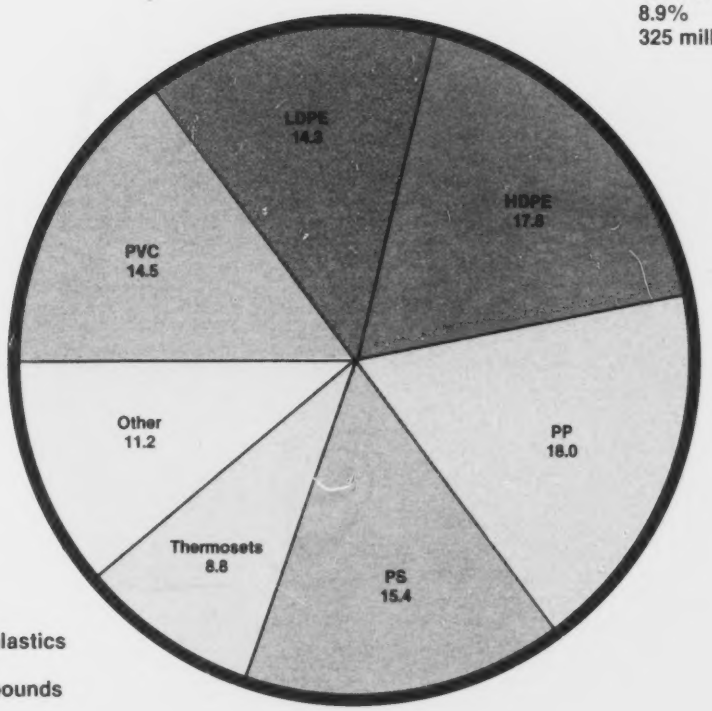
ALL OTHER


Million Pounds
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
2,216
1,771
2,729
3,443
3,054
3,232
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983


Million Pounds
2,600
2,400
2,200
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
2,335
1,920
1,906
2,006
2,471
1,108
1,134
1,353
1,226
1,165
1979
1980
1981
1982
1983
Resellers & Compounders
Sales Unclassified

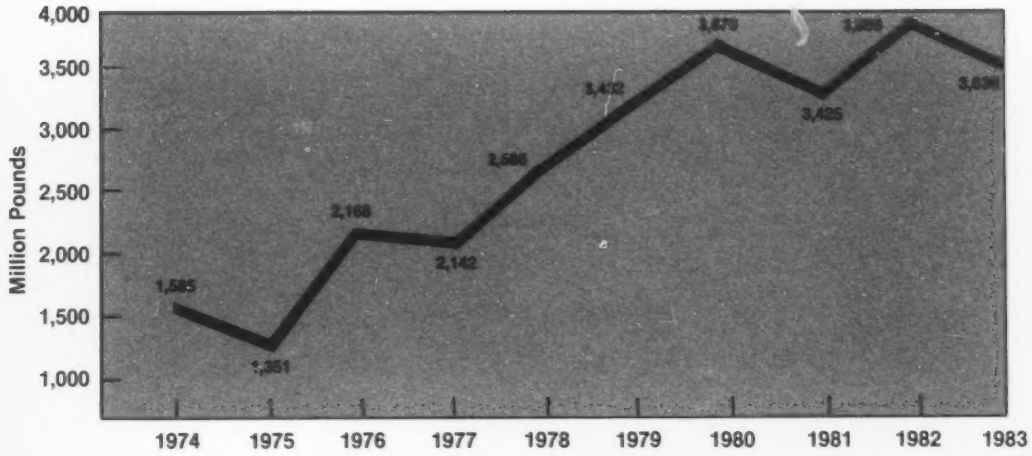
ALL OTHER (cont'd.)

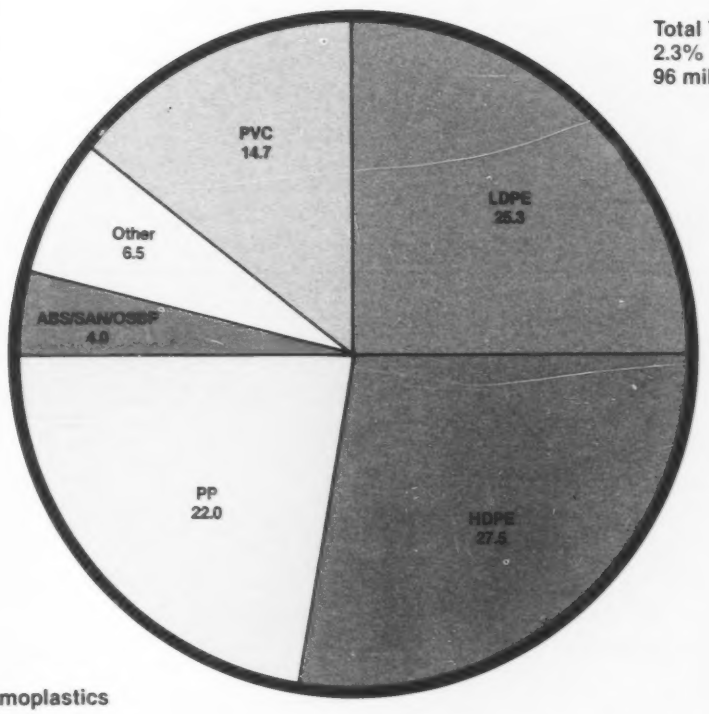
Total Thermosets
8.9%
325 million pounds



Total Thermoplastics
91.1%
3,311 million pounds

EXPORTS





Total Thermosets
2.3%
96 million pounds

Total Thermoplastics
97.7%
4,054 million pounds

APPENDIX A

Table of 1983 distribution of plastics resins sales and use by Major Market, including market segments.

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1983 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis) (1)

MAJOR MARKET	TOTAL THERMOSETS		TOTAL THERMOPLASTICS		GRAND TOTAL (EXCLUDING POLYURETHANE FOAM)		POLYURETHANE FOAM	
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	509	9.0	1,387	4.0	1,896	4.7	311	16.3
Motor Vehicles and Parts	237	4.2	1,297	3.7	1,534	3.8		
Ships, Boats and Recreational Vehicles	235	4.2	56	0.2	291	0.7		
All Other Transportation Equipment	37	0.6	34	0.1	71	0.2		
PACKAGING, TOTAL	62	1.1	11,751	33.7	11,813	29.2	85	4.4
Bottles, Jars, Vials			2,310	6.6				
Food Containers Including Disposable Cups			1,591	4.6				
Blister and Bubble Containers	-	-	186	0.5	186	0.5		
Flexible Packaging - *(Bags, Liners, Etc.)*			5,455	15.6				
Household and Institutional Refuse Bags & Film	-	-	2,267	6.5	2,267	5.6		
All Other Flexible Packaging			3,188	9.1				
All Other Packaging	38	0.7	2,209	6.3	2,247	5.5		
BUILDING AND CONSTRUCTION, TOTAL	3,312	58.9	5,240	15.0	8,552	21.1	379	19.9
Pipe, Conduit and Fittings	100	1.8	3,079	8.8	3,179	7.8		
Building Materials for All Structures	2,583	45.9	1,636	4.7	4,219	10.4		
Siding	1,069	19.0	321	0.9	1,390	3.4		
Flooring	513	9.1	559	1.6	1,072	2.6		
Insulation Material	538	9.6	264	0.8	802	2.0		
All Other Building Materials for All Structures	463	8.2	492	1.4	955	2.4		
All Other Building and Construction	629	11.2	525	1.5	1,154	2.9		
ELECTRICAL/ELECTRONIC, TOTAL	366	6.5	2,148	6.2	2,514	6.2	87	4.6
Home and Industrial Appliances	109	1.9	732	2.1	841	2.1		
Communications Equipment	26	0.5	297	0.9	323	0.8		
Electric Industrial Equipment Combined with Electronic Components Storage Batteries	231**	4.1**	1,119**	3.2**	1,350**	3.3**		
FURNITURE AND FURNISHINGS, TOTAL	181	3.2	1,826	5.2	2,007	5.0	985	51.6
Rigid Furniture	177	3.1	174	0.5	351	0.9		
Flexible Furniture			95	0.3				
Carpet and Carpet Components			877	2.5				
Other Textiles and Furnishings			680	1.9				
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	207	3.7	3,609	10.4	3,816	9.4		
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.	99	1.8	940	2.7	1,039	2.6		
Health Care and Medical Products			619	1.8				
Toys and Sporting Goods	25	0.4	436	1.3	461	1.1		
Hobby and Graphic Arts Supplies			331	0.9				
All Other Consumer and Institutional Products	73	1.3	1,283	3.7	1,356	3.3		
INDUSTRIAL/MACHINERY, TOTAL	32	0.6	286	0.8	318	0.8		
ADHESIVES/INKS/COATINGS, TOTAL	535	9.5	1,265	3.6	1,800	4.4		
Adhesives and Sealants	81	1.4	464	1.3	545	1.3		
All Other Inks and Coatings	454	8.1	801	2.3	1,255	3.1		
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	325	5.8	3,311	9.5	3,636	9.0	62	3.2
Resellers and Compounders	115	2.0	2,356	6.8	2,471	6.1		
Sales Unclassified	210	3.8	955	2.7	1,165	2.9		
EXPORTS, TOTAL	96	1.7	4,054	11.6	4,150	10.2		
GRAND TOTAL	5,625	100.0	34,877	100.0	40,502	100.0	1,909	100.0

RELEASE DATE: JUNE 1, 1984

Page 1 (1) = Except phenolic resins which are on a gross weight basis

SOURCE: SPI COMMITTEE ON RESIN STATISTICS AS COMPILED BY ERNST & WHINNEY

** = Includes Storage Batteries

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1983 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis) (1)

MAJOR MARKET	EPOXY		POLYESTER		UREA & MELAMINE		PHENOLICS		ALL OTHER THERMOSETS			
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	D	D	316	29.5	D	D	156	6.2	D	D		
Motor Vehicles and Parts			115	10.7			115	4.5				
Ships, Boats and Recreational Vehicles			191	17.8								
All Other Transportation Equipment			10	1.0								
PACKAGING, TOTAL	D	D	-	-	45	3.3	D	D	-	-		
Bottles, Jars, Vials					-							
Food Containers Including Disposable Cups												
Blister and Bubble Containers					-							
Flexible Packaging - *(Bags, Liners, Etc.)*												
Household and Institutional Refuse Bags & Film					-							
All Other Flexible Packaging												
All Other Packaging												
BUILDING AND CONSTRUCTION, TOTAL	36	10.9	496	46.3	844	62.6	1,93[illegible]	76.6	-	-		
Pipe, Conduit and Fittings			70	6.5			10	0.4				
Building Materials for All Structures	16	4.8	136	12.7			1,813	71.7				
Siding			54	5.0			759	30.0				
Flooring							290	11.5				
Insulation Material	-	-					533	21.1				
All Other Building Materials for All Structures			79	7.4			231	9.1				
All Other Building and Construction			290	27.1			113	4.5				
ELECTRICAL/ELECTRONIC, TOTAL	73	22.0	52	4.9	D	D	176	7.0	D	D		
Home and Industrial Appliances							87	3.4				
Communications Equipment							17	0.7				
Electric Industrial Equipment Combined with Electronic Components			32	3.0			72**	2.9				
Storage Batteries	-	-	-	-								
FURNITURE AND FURNISHINGS, TOTAL	D	D	2	0.2	D	D	D	D	-	-		
Rigid Furniture												
Flexible Furniture												
Carpet and Carpet Components												
Other Textiles and Furnishings			-	-								
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	D	D	81	7.6	D	D	44	1.7	-	-		
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.												
Health Care and Medical Products							-					
Toys and Sporting Goods			22	2.1			-					
Hobby and Graphic Arts Supplies			8	0.7			-					
All Other Consumer and Institutional Products			46	4.3								
INDUSTRIAL/MACHINERY, TOTAL	D	D	D	D	-	-	11	0.4	-	-		
ADHESIVES/INKS/COATINGS, TOTAL	118	35.7	D	D	D	D	70	2.8	300	87.0		
Adhesives and Sealants	21	6.4							-	-		
All Other Inks and Coatings	97	29.3							300	87.0		
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	D	D	96	9.0	110	8.2	84	3.3	D	D		
Resellers and Compounders			45	4.2								
Sales Unclassified			51	4.8								
EXPORTS, TOTAL	35	10.6	10	0.9	21	1.6	23	0.9	7	2.0		
GRAND TOTAL	331	100.0	1,072	100.0	1,348	100.0	2,529	100.0	345	100.0		

Page 2 Note: Table does not add vertically or horizontally due to disclosure.

SOURCE: SPI COMMITTEE ON RESIN STATISTICS AS COMPILED BY ERNST & WHINNEY

D = Disclosure (1) = Except phenolic resins which are on a gross weight basis.

THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1983 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis)

MAJOR MARKET	LOW DENSITY POLYETHYLENE		HIGH DENSITY POLYETHYLENE		POLYPROPYLENE		ABS, OSBP & SAN		POLYSTYRENE		SBL & OSBL	
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	D	D	121	2.1	293	6.6	267	20.1	12	0.3	-	-
Motor Vehicles and Parts							257	19.3	6	0.2		
Ships, Boats and Recreational Vehicles												
All Other Transportation Equipment												
PACKAGING, TOTAL	5,377	66.8	2,591	45.4	845	18.9	51	3.9	1,486	41.2	D	D
Bottles, Jars, Vials	31	0.4	1,118	19.6	119	2.7			352	9.8		
Food Containers Including Disposable Cups	282	3.5	552	9.7	50	1.1	6	0.5	617	17.1		
Blister and Bubble Containers			-	-	-	-			-	-		
Flexible Packaging - *(Bags, Liners, Etc.)*	4,382	54.5	250	4.4	325	7.2	-	-				
Household and Institutional Refuse Bags & Film	1,946	24.2	90	1.6			-	-	-	-		
All Other Flexible Packaging	2,436	30.3	160	2.8			-	-				
All Other Packaging			671	11.7	351	7.9						
BUILDING AND CONSTRUCTION, TOTAL	226	2.8	518	9.1	22	0.5	197	14.8	294	8.2	D	D
Pipe, Conduit and Fittings					7	0.2			8	0.2		
Building Materials for All Structures	54	0.7			13	0.3			249	6.9		
Siding	-	-			-	-	-	-	-	-		
Flooring	-	-	-	-	-	-			-	-		
Insulation Material			-	-					240	6.7		
All Other Building Materials for All Structures									9	0.2		
All Other Building and Construction					2	0.0	23	1.7	37	1.1		
ELECTRICAL/ELECTRONIC, TOTAL	374	4.6	123	2.2	242	5.4	246	18.5	307	8.5	-	-
Home and Industrial Appliances					101	2.3			267	7.4		
Communications Equipment									-			
Electric Industrial Equipment Combined with Electronic Components			85**	1.5**					40**	1.1**		
Storage Batteries												
FURNITURE AND FURNISHINGS, TOTAL	D	D	D	D	983	22.0	7	0.5	47	1.3	321	45.9
Rigid Furniture									20	0.6	-	-
Flexible Furniture							-	-	-	-	-	-
Carpet and Carpet Components					544	12.2			-	-	292	41.8
Other Textiles and Furnishings									27	0.7	29	4.1
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	560	7.0	526	9.2	580	13.0	168	12.7	820	22.8	D	D
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.	181	2.3	192	3.4	142	3.2	29	2.2	344	9.5		
Health Care and Medical Products	136	1.7	35	0.6	261	5.9			72	2.0		
Toys and Sporting Goods	48	0.6	129	2.3	45	1.0	35	2.6	150	4.2		
Hobby and Graphic Arts Supplies	-	-			23	0.5			46	1.3		
All Other Consumer and Institutional Products	195	2.4			109	2.4			208	5.8		
INDUSTRIAL/MACHINERY, TOTAL	D	D	109	1.9	D	D	47	3.5	D	D	-	-
ADHESIVES/INKS/COATINGS, TOTAL	D	D	D	D	D	D	27	2.0	D	D	300	43.1
Adhesives and Sealants												
All Other Inks and Coatings												
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	519	6.5	646	11.3	653	14.6	175	13.2	559	15.5	5	0.7
Resellers and Compounders	423	5.3	507	8.9	523	11.7			333	9.2		
Sales Unclassified	96	1.2	139	2.4	130	2.9			226	6.3		
EXPORTS, TOTAL	919	11.4	1,001	17.5	800	17.9	144	10.8	77	2.1	10	1.4
GRAND TOTAL	8,045	100.0	5,707	100.0	4,464	100.0	1,329	100.0	3,606	100.0	699	100.0

Note: Table does not add vertically or horizontally due to disclosure.

SOURCE: SPI COMMITTEE ON RESIN STATISTICS AS COMPILED BY ERNST & WHINNEY

D = Disclosure
** = Includes Storage Batteries

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THE SOCIETY OF THE PLASTIC INDUSTRY, INC.

1983 DISTRIBUTION OF PLASTIC RESINS SALES & USE *(CAPTIVE)* BY MAJOR MARKET

(In millions of pounds, dry weight basis)

MAJOR MARKET	NYLON		PVC		PVAc, PVOH & OTHER VINYL RESINS		THERMOPLASTIC POLYESTER		ALL OTHER THERMOPLASTICS			
	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL	QUANTITY	% OF TOTAL
TRANSPORTATION, TOTAL	109	33.1	150	2.4	D	D	37	4.7	343	12.4		
Motor Vehicles and Parts	92	28.0	137	2.2			37	4.7	340	12.3		
Ships, Boats and Recreational Vehicles							-	-				
All Other Transportation Equipment							-	-				
PACKAGING, TOTAL	40	12.2	546	8.9	D	D	570	72.8	133	4.8		
Bottles, Jars, Vials			140	2.3					17	0.6		
Food Containers Including Disposable Cups	-	-										
Blister and Bubble Containers	-	-	99	1.6					25	0.9		
Flexible Packaging - *(Bags, Liners, Etc.)*			248	4.0					60	2.2		
Household and Institutional Refuse Bags & Film	-	-	147	2.4			-	-				
All Other Flexible Packaging			101	1.6								
All Other Packaging												
BUILDING AND CONSTRUCTION, TOTAL	D	D	3,329	54.1	19	1.9	-	-	607	22.0		
Pipe, Conduit and Fittings			2,347	38.2	-	-			20	0.7		
Building Materials for All Structures									530	19.2		
Siding			302	4.9	-	-						
Flooring			332	5.4	-	-						
Insulation Material					-	-			-	-		
All Other Building Materials for All Structures									312	11.3		
All Other Building and Construction									57	2.1		
ELECTRICAL/ELECTRONIC, TOTAL	60	18.2	386	6.3	D	D	D	D	356	12.9		
Home and Industrial Appliances			43	0.7								
Communications Equipment			82	1.3								
Electric Industrial Equipment Combined with Electronic Components	48**	14.6	261**	4.3**								
Storage Batteries												
FURNITURE AND FURNISHINGS, TOTAL	9	2.7	289	4.7	60	6.0	D	D	50	1.8		
Rigid Furniture			9	0.1					45	1.6		
Flexible Furniture	-	-			-	-			-	-		
Carpet and Carpet Components									-	-		
Other Textiles and Furnishings			208	3.4					5	0.2		
CONSUMER AND INSTITUTIONAL PRODUCTS, TOTAL	D	D	293	4.8	59	5.9	10	1.3	566	20.5		
Dinner, Table & Kitchenware, Picnic Jugs, Ice chests, Etc.									1	0.0		
Health Care and Medical Products			48	0.8					35	1.3		
Toys and Sporting Goods			16	0.3	-	-	-	-	8	0.3		
Hobby and Graphic Arts Supplies			16	0.3					234	8.5		
All Other Consumer and Institutional Products									288	10.4		
INDUSTRIAL/MACHINERY, TOTAL	28	8.5	20	0.3	-	-	9	1.2	30	1.1		
ADHESIVES/INKS/COATINGS, TOTAL	D	D	77	1.2	656	65.4	D	D	125	4.5		
Adhesives and Sealants			27	0.4	307	30.6			62	2.2		
All Other Inks and Coatings			50	0.8	349	34.8			63	2.3		
ALL OTHER (RESELLERS, COMPOUNDERS), TOTAL	31	9.4	528	8.6	20	2.0	13	1.7	162	5.9		
Resellers and Compounders	14	4.2	310	5.0					125	4.5		
Sales Unclassified	17	5.2	218	3.6					37	1.4		
EXPORTS, TOTAL	24	7.3	534	8.7	71	7.1	86	11.0	388	14.1		
GRAND TOTAL	329	100.0	6,152	100.0	1,003	100.0	783	100.0	2,760	100.0		

Page 4 Note: Table does not add vertically or horizontally due to disclosure.

SOURCE: SPI COMMITTEE ON RESIN STATISTICS AS COMPILED BY ERNST & WHINNEY

D = Disclosure
** = Includes Storage Batteries

PROCESSING & MACHINERY

PROCESSING METHODS

INJECTION MOLDING

Injection molding is the principal method of forming thermoplastic materials. Modifications of the injection process are sometimes used for thermosetting plastics.

In injection molding, plastic material is put into a hopper which feeds into a heating chamber. A plunger pushes the plastic through this long heating chamber where the material is softened to a fluid state. At the end of this chamber there is a nozzle which abuts firmly against an opening into a cool, closed mold. The fluid plastic is forced at high pressure through this nozzle into the cold mold. As soon as the plastic cools to a solid state, the mold opens and the finished plastic is ejected from the press.

THe problem with injection molding of thermosetting materials is that, under heat, these plastics will first soften, then harden to an infusible state. Thus it is essential that no softened thermosetting material in the heating chamber be allowed to remain there long enough to set.

Jet molding, offset molding and molding using a screw-type machine overcome this problem by liquefying the thermosetting plastic material just as it goes through the injection nozzle into the mold, but not before.

BLOW MOLDING

Blow molding is a method of forming used with thermoplastic materials.

Basically, blow molding consists of stretching and then hardening a plastic against a mold. There are two general methods of doing this type of thermoplastic molding: the direct method and the indirect method, encompassing several variations of each.

In the direct method, a glob of molten thermoplastic material is formed into the rough shape of the desired finished product. This shape is then inserted in a female mold and air blown into the plastic, as into a balloon, to force it against the sides of the mold. The formed material is then cooled before removal from the mold.

In the indirect method, a thermoplastic sheet or special shape is first heated, then clamped between a die and cover. Air pressure forced between the plastic and the cover forces the material into contact with the die, which has the contour desired in the finished product. The plastic is cooled before removal from contact with the die.

COMPRESSION MOLDING

Compression molding is the most common method of forming thermosetting materials. It is not generally used for thermoplastics.

Compression molding is simply the squeezing of a material into a desired shape by application of heat and pressure to the material in a mold.

Plastic molding powder, mixed with such materials or fillers as woodflour, cellulose and asbestos to strengthen or give other added qualities to the finished product, is put directly into the open mold cavity. The mold is then closed, pressing down on the plaastic and causing it to flow throughout the mold. It is while the heated mold is closed that the thermosetting material undergoes a chemical change which permanently hardens it into the shape of the mold. The three compression molding factors—pressure, temperature and time mold is closed—vary with the design of the finished article and the material being molded.

EXTRUSION

Extrusion molding is the method employed to form thermoplastic materials into continuous sheeting, film, tubes, rods, profile shapes, filaments, and to coat wire, cable and cord.

In extrusion, dry plastic material is first loaded into a hopper, then fed into a long heating chamber through which it is moved by the action of a continuously revolving screw. At the end of the heating chamber the molten plastic is forced out through a small opening or die with the shape desired in the finished product. As the plastic extrusion comes from the die, it is fed onto a conveyor belt where it is cooled, most frequently by blowers or by immersion in water.

In the case of wire and cable coating, the thermoplastic is extruded around a continuing length of wire or cable which, like the plastic, passes through the extruder die. The coated wire is wound on drums after cooling.

In producing wide film or sheeting, the plastic is extruded in the form of a tube. This tube may be split as it comes from the die and then stretched and thinned to the dimensions desired in the finished film.

In a different process, the extruded tubing is inflated as it comes from the die, the degree of inflation of the tubing regulating the thickness of the final film.

THERMOFORMING

Thermoforming of plastic sheet has developed rapidly in recent years. Basically, this process consists of heating thermoplastic sheet to a formable plastic state and then applying air and/or mechanical assists to shape it to the contours of a mold.

Air pressure may range from almost zero to several hundred psi. Up to approximately 14 psi (atmospheric pressure), the pressure is obtained by evacuating the space between the sheet and the mold in order to utilize this atmospheric pressure. This range, known as *vacuum forming,* will give satisfactory reproduction of the mold configuration in the majority of forming applications.

TRANSFER MOLDING

Transfer molding is most generally used for thermosetting plastics.

This method is like compression molding in that the plastic is cured into an infusible state in a mold under heat and pressure. It differs from compression molding in that the plastic is heated to a point of plasticity before it reaches the mold and is forced into a closed mold by means of an hydraulically-operated plunger.

Transfer molding was developed to facilitate the molding of intricate products with small deep holes or numerous metal inserts. The dry molding compound used in compression molding sometimes disturbs the position of the metal inserts and the pins which form the holes. The liquefied plastic material in transfer molding flows around these metal parts without causing them to shift position.

REACTION INJECTION MOLDING

Reaction injection molding (RIM) is a relatively new processing technique that has rapidly taken its place alongside more traditional methods. Unlike liquid casting, the two liquid components, polyols and isocyanates, are mixed in a chamber at relatively low temperatures (75°-140°) before injection into a closed mold. An exothermic reaction occurs and consequently RIM requires far less energy usage than any other injection molding system.

The three major types of polyurethane RIM systems are rigid structural foam, low-modulus elastomers, and high-modulus elastomers.

Reinforced RIM (R-RIM) consists in the addition of such materials as chopped or milled glass fiber to the polyurethane to enhance stiffness and to increase modulus thus expanding the range of applications.

DOLLAR SALES OF PLASTICS MACHINERY

(in millions of dollars)

MACHINE TYPE	1979	1980	1981	1982	1983
Injection Molding	352.2	296.7	311.2	225.0	315.0
Structural Foam	10.6	11.7	8.7	5.0	4.5
Extrusion, single screw	195.7	203.5	201.0	140.0	150.0
Extrusion, multi screw	27.3	25.9	23.3	19.0	18.5
Blow Molding	91.0	100.0	100.0	89.0	90.0
Thermoforming	25.0	26.2	32.0	28.0	33.0
Reaction-Injection Molding	5.2	6.7	7.8	6.0	8.0
Compression	27.5	24.2	24.4	17.5	17.0
Expanded Bead	15.0	14.8	15.5	5.0	8.0
Transfer Molding	7.8	8.1	8.0	6.0	5.5
Total	757.3	717.8	731.9	540.5	649.5

Source: *Modern Plastics* Magazine

SHIPMENTS OF SINGLE SCREW EXTRUSION MACHINERY

(in number of units)

SCREW DIAMETER	1979	1980	1981	1982	1983
Up To But Not Including 1¼"	a	a	a	a	a
1¼" Up To But Not Including 2"	174	156	121	129	168
2" Up To But Not Including 2½"	133	127	171	131	126
2½" Up To But Not Including 3"	231	248	254	184	163
3" Up To But Not Including 4"	200	257	182	148	165
4" Up To But Not Including 5½"	187	245	196	127	85
5½" Up To But Not Including 7½"	68	73	64	45	60
Includes 7½" & Larger	20	16	21	8	5
Total	1,013	1,122	1,009	772	772

[a] Combined with 1¼"-2"

Note: Includes domestic shipments and exports

Source: SPI Machinery Division

SHIPMENTS OF INJECTION MOLDING MACHINERY

(in number of units)

CLAMP FORCE (Tons)	1979	1980	1981	1982	1983
Domestic Shipments					
0-99	630	448	c	c	c
100-199	542	344	838	683	848
200-299	647	441	433	d	363
300-399	702	465	453	253	b
400-499	77	b	325	276	b
500-599	223	236	d	89	543
600-749	106	82	d	83	f
750-1199	81[a]	28	d	e	f
1200 and over	—	17	d	e	106
Total	3,008	2,061	2,049	1,384	1,860
Export Shipments					
0-99	47	37	c	c	c
100-199	28	34	51	25	34
200-299	36	48	31	d	12
300-399	19	31	25	13	b
400-499	11	b	76	25	b
500-599	29	32	d	8	14
600-749	28	33	d	14	f
750-1199	9[a]	6	d	e	f
1200 and over	—	6	d	e	2
Total	207	227	183	85	62
Total Shipments					
0-99	677	485	c	c	c
100-199	570	378	889	708	882
200-299	683	489	464	d	375
300-399	721	496	478	266	b
400-499	88	b	401	301	b
500-599	252	268	d	97	557
600-749	134	115	d	97	f
750-1199	90[a]	34	d	e	f
1200 and over	—	23	d	e	108
Grand Total	3,215	2,288	2,232	1,469	1,922

[a] Category was 750 and over in 1979 [b] Combined with 500-599 [c] Combined with 100-199
[d] Combined with 400-499 [e] Combined with 600-749 [f] Combined with 1200 and over
Source: SPI Machinery Division

OTHER SOURCES OF PLASTICS INFORMATION

Business Consulting Groups and Publishers

Business Communications Co., Inc.—9 Viaduct Rd., Box 2070C, Stamford, Conn. 06906—203/325-2208

Chem Systems Inc.—303 S. Broadway, Tarrytown, N.Y. 10591—914/631-2828

Eldib Engineering & Research, Inc.—613 Springfield Ave., Berkeley Heights, N.J. 07922—201/464-2244

Frost & Sullivan, Inc.—106 Fulton St., New York, N.Y. 10038—212/233-1080

Hull & Co.—5 Oak St., Greenwich, Conn. 06830—203/622-9120

Charles H. Kline & Co.—330 Passaic Ave., Fairfield, N.J. 07006—201/227-6262

R.M. Kossoff & Associates, Inc.—10 Rockefeller Plaza, New York, N.Y. 10020—212/246-4035

Arthur D. Little, Inc.—35 Acorn Park, Cambridge, Mass. 02140—617/864-5770

Margolis Marketing & Research Co.—232 Madison Ave., Suite 905, New York, N.Y. 10016—212/685-1278

Morton Research Corporation—1745 Merrick Avenue, Merrick, N.Y. 11566—516/378-1066

Noyes Data Corp.—Mill Road at Grand Ave., Park Ridge, N.J. 07656—201/391-8484

Predicasts, Inc.—200 University Circle Research Center, 11001 Cedar Ave., Cleveland, Ohio 44106—216/795-3000

Peter Sherwood Associates, Inc.—20 Harlem Ave., White Plains, N.Y. 10603—914/761-3033

Skeist Laboratories, Inc.—112 Naylon Ave., Livingston, N.J. 07039—201/994-1050

Springborn Group—P.O. Box J, Hazardville Station, Enfield, Conn. 06082—203/749-8371

SRI International—333 Ravenswood Ave., Menlo Park, Cal. 94025—415/326-6200

Technomic Publishing Co.—851 New Holland Ave., Box 3535, Lancaster, PA 17604

Technomic Consultants, Inc.—One Liberty Square, Boston, MA 02109—617/542-8733

Government Publications

Annual Survey of Manufactures—Bureau of the Census

Census of Manufactures—Bureau of the Census

Current Industrial Reports—Bureau of the Census

Foreign Trade Reports: FT 135 (imports), FT 410 (exports)—Bureau of the Census

Guide to Census Bureau Data Files and Special Tabulations—Bureau of the Census

Guide to Foreign Trade Statistics—Bureau of the Census

Producer Price Indexes—Bureau of Labor Statistics

Standard Industrial Classification Manual—Office of Management and Budget

Statistical Abstract of the U.S.—Department of Commerce

Statistical Services of the U.S. Government—Office of Management and Budget

Synthetic Organic Chemicals—International Trade Commission

U.S. Industrial Outlook—Department of Commerce

Newspapers

Chemical Marketing Reporter—100 Church St., New York, N.Y. 10007—212/732-9820

Journal of Commerce—110 Wall St., New York, N.Y. 10005—212/425-1616

Rubber & Plastics News—1 Cascade Plaza, Suite 1Q02, Akron, Ohio 44308—216/253-2183

Trade Associations & Professional Organizations

American Chemical Society—1155 16th St. N.W., Washington, D.C. 20036—202/872-4600
Chemical Manufacturers Assn.—2501 M St. NW, Washington, D.C. 20037—202/887-1100
Chemical Marketing Research Assn.—139 Chestnut Ave., Staten Island, N.Y. 10305—212/727-0550
Chemical Specialties Manufacturers Assn.—1001 Connecticut Ave., NW, Washington, D.C. 20036 —202/872-8110
Composite Can & Tube Institute—1742 N St. NW, Washington, D.C. 20036—202/223-4840
Drug, Chemical & Allied Trades Assn.—42-40 Bell Blvd., Suite 604, Bayside, N.Y. 11361—212/229-8891
Dry Color Manufacturers Assn.—Suite 202, 206 N. Washington St., Alexandria, VA 22314—703/684-4044
Flexible Packaging Assn.—Suite 500, 1090 Vermont Ave., N.W., Washington, D.C. 20005—202/842-3880
INDA—1700 Broadway, New York, N.Y. 10019—212/582-8401
International Institute of Synthetic Rubber Producers—2077 S. Gessner Rd., Suite 133, Houston, TX 77063—713/783-7511
International Isocyanate Institute—P.O. Box 1268, New Canaan, CT 06840—203/966-755
National Paint & Coatings Assn.—1500 Rhode Island Ave. NW, Washington, D.C. 20005 —202/462-6272
Polyurethane Manufacturers Assn.—999 N. Main St., Glen Ellyn, IL 60137—312/858-2670
Rubber Manufacturers Assn.—1400 K Street, NW, Washington, D.C. 20005—202/682-1338
Society of Plastics Engineers—14 Fairfield Drive, Brookfield Center, CT 06805—203/775-0471
Society of the Plastics Industry-Canada—1262 Don Mills Road, Don Mills, Ontario M3B2W7 —416/449-3444
Synthetic Organic Chemical Manufacturers Assn.—1075 Central Park Ave., Scarsdale, N.Y. 10583 —914/725-1492

Trade Publications

Canadian Plastics—1450 Don Mills Road, Don Mills, Ontario M3B2X7—416/445-6641
Chemical Engineering—1221 Ave. of the Americas, New York, N.Y. 10020—212/997-2464
Chemical & Engineering News—733 Third Ave., New York, N.Y. 10017—212/679-6210
Chemical Week—1221 Ave of the Americas, New York, N.Y. 10020—212/997-2922
Market Search, Inc.—P.O. Box 2886, Toledo, OH 43606
Materials Engineering—Penton Plaza, Cleveland, Ohio 44114—216/696-7000
Modern Packaging—205 East 42nd St., New York, N.Y. 10017—212/573-8107
Modern Plastics—1221 Ave. of the Americas, New York, N.Y. 10020—212/997-1221
Packaging Digest—201 East 42nd St., New York, N.Y. 10017—212/867-9191
Plastics Compounding—1129 East 17th Ave., Denver, CO 80218—303/832-1022
Plastics Design Forum—1129 East 17th Ave., Denver CO 80218—303/832-1022
Plastics Design & Processing—700 Peterson Rd., Libertyville, IL 60048—312/362-8711
Plastics Engineering—14 Fairfield Drive, Brookfield Center, CT 06805—203/775-0471
Plastics Focus—95 Madison Ave., Room 800, New York, N.Y. 10017—212/679-7902
Plastics Industry News—1129 East 17th Ave., Denver, CO 80218—303/832-1022
Plastics Machinery & Equipment—1129 East 17th Ave., Denver, CO 80218—303/832-1022
Plastics Technology—633 Third Ave., New York, N.Y. 10017—212/986-4800
Plastics World—221 Columbus Ave., Boston, MA 02116—617/536-7780

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on
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Epoxy	Polypropylene	Other Styrene-based Polymers
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Melamine	Polystyrene	Polyvinyl Acetate
Phenolic	Styrene Butadiene Latexes	Polyvinyl Alcohol
LD Polyethylene	Other Styrene-based	Other Vinyl Resins
HD Polyethylene	Latexes	Thermoplastic Polyester

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MONTHLY STATISTICAL REPORT
THE SOCIETY OF THE PLASTICS INDUSTRY, INC.
(In thousands of pounds, dry weight basis)

THERMOSETTING RESINS

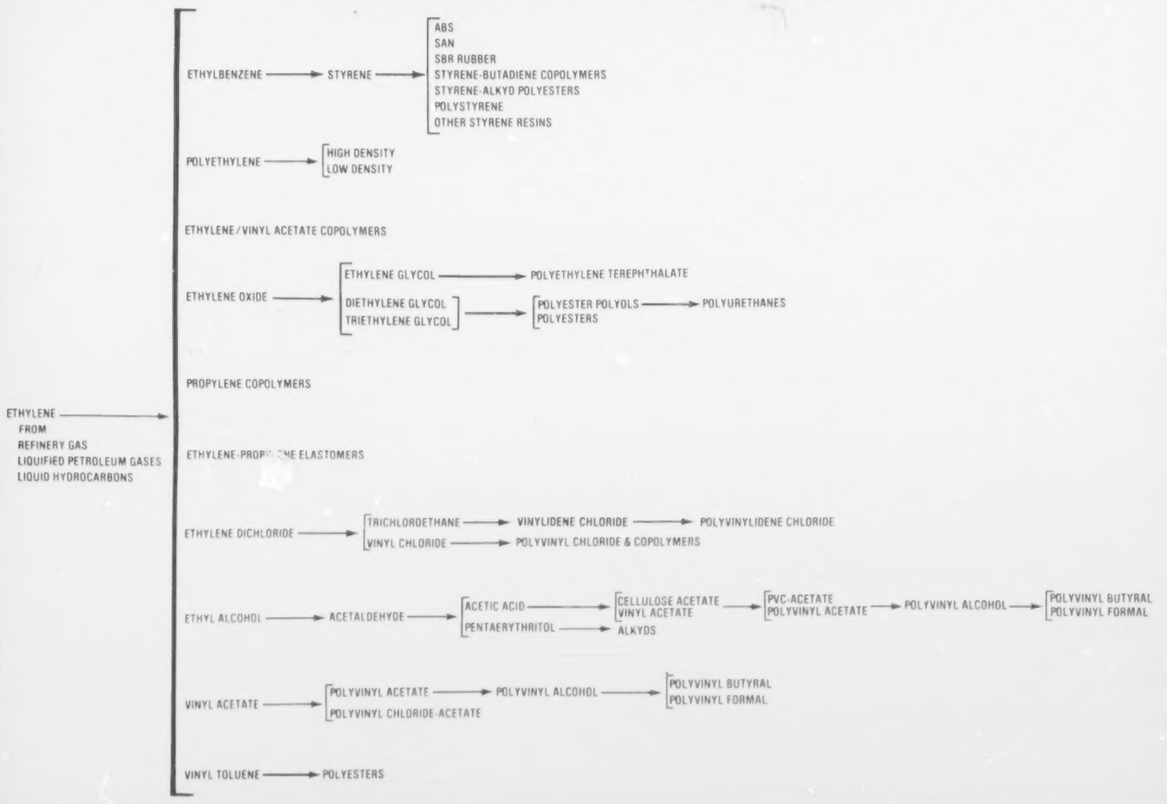
DECEMBER 1980

RESIN KIND & USE	SALES & CAPTIVE USE						PRODUCTION					
	DECEMBER			YEAR-TO-DATE			DECEMBER			YEAR-TO-DATE		
	1980	1979	% Change	1980	1979	% Change	1980	1979	% Change	1980	1979	% Change
EPOXY (UNMODIFIED) RESINS, TOTAL	30,709	25,639	+ 19.8	318,756R	331,970	– 4.0	26,491	24,829	+ 6.7	315,039R	361,077	– 12.8
Total Exports	3,732	3,496	+ 6.8	35,547	35,730	– 0.5						
Total Domestic	26,977	22,143	+ 12.8	283,209R	296,240	– 4.4						
Bonding & Adhesives	1,931	1,431	+ 34.9	17,742R	17,454	+ 1.7						
Flooring, Paving & Exposed Aggregate	1,886	1,481	+ 27.3	19,231R	19,583	– 1.8						
Protective Coatings	13,417	9,648	+ 39.1	137,308R	146,137	– 6.0						
Fiber Reinforced Laminates & Composites	5,164	4,785	+ 7.9	62,690R	60,268	+ 4.0						
Tooling, Casting & Molding Resins	2,749	2,417	+ 13.7	25,664R	30,940	– 17.1						
All Other Uses	1,830	2,381	– 23.1	20,574R	21,858	– 5.9						
POLYESTER (UNSATURATED) RESINS, TOTAL	75,749	76,020	– 0.4	921,169R	1,151,581	– 20.0	76,524	78,733	– 2.8	925,947R	1,147,174	– 19.3
General Purpose Resins							66,503	68,719	– 3.2	805,583R	1,010,750	– 20.3
Fire Retardant Resins							2,757	2,550	+ 8.1	28,739	32,035	– 10.3
Chemical Resistant Resins							7,264	7,464	– 2.7	91,625R	104,389	– 12.2
Isophthalic Resins							3,830	4,917	– 22.1	52,437R	63,158	– 17.0
All Other Resins							3,434	2,547	+ 34.8	39,188R	41,231	– 5.0
Total Exports	903	841	+ 7.4	11,254	14,250	– 21.0						
Total Domestic	74,846	75,179	– 0.4	909,916R	1,137,061	– 20.0						
Reinforced Plastics, Total	59,069	58,428	+ 1.1	709,229R	905,949	– 21.7						
Non-Reinforced Plastics, Total	15,777	16,751	– 5.8	200,686R	231,112	– 13.2						
LOW-DENSITY POLYETHYLENE 0.940 & BELOW, TOTAL	719,992	666,312	+ 8.1	7,467,465R	7,814,845	– 4.4	675,113	650,391	+ 3.8	7,290,727R	7,793,223	– 6.4
Total Exports	109,576	65,000	+ 68.6	1,147,442R	897,575	+ 27.8						
Total Domestic	610,416	65,000	+ 68.6	1,147,442R	897,575	+ 27.8						
Film (12 Mils & Below)	610,416	601,312	+ 1.5	6,320,023R	6,917,270	– 8.6						
Sheet (Over 12 Mils)	392,242	383,360	+ 2.3	4,003,749	4,363,250	– 8.2						
Injection Molding	921	1,930	– 52.3	18,176	25,825	– 29.6						
Wire & Cable	46,555	57,100	– 18.5	519,294R	649,975	– 20.1						
Extrusion Coating	20,042	34,572	– 42.0	335,403	424,139	– 20.9						
Blow Molding	44,772	41,001	+ 9.2	517,406R	539,098	– 4.0						
Pipe & Conduit	5,129	4,786	+ 7.2	65,453R	59,524	+ 10.0						
Other Extruded Products	2,660	2,293	+ 16.0	21,768R	32,718	– 33.5						
All Other Uses	4,244	5,140	– 17.4	56,018R	79,614	– 29.6						
HIGH-DENSITY POLYETHYLENE ABOVE 0.940, TOTAL	93,851	71,130	+ 31.9	782,756R	743,127	+ 5.3						
Total Exports	413,377	394,243	+ 4.9	4,393,038R	4,893,243	– 10.2	407,174	419,864	– 3.0	4,405,021	5,009,839	– 12.1
Total Domestic	61,114	54,188	+ 12.8	526,438R	608,654	– 13.5						
Film (12 Mils & Below)	352,263	340,055	+ 3.6	3,866,600	4,284,589	– 9.8						
Sheet (Over 12 Mils)	21,622	14,714	+ 46.9	201,086	212,399	– 5.3						
Injection Molding	7,921	4,541	+ 74.4	54,937	65,520	– 16.2						
Wire & Cable	89,601	84,541	+ 6.0	937,964	1,073,724	– 12.6						
Extrusion Coating	6,285	7,074	– 11.2	105,555	125,921	– 16.2						
Blow Molding	3,213	2,038	+ 57.7	27,565	30,242	– 8.9						
Pipe & Conduit	138,158	139,521	– 1.0	1,573,140	1,724,076	– 8.8						
Other Extruded Products	30,468	25,135	+ 21.2	368,352	400,395	– 8.0						
All Other Uses	1,703	2,120	– 19.7	24,250	18,931	+ 28.1						
	53,282	60,371	– 11.7	573,751	633,381	– 9.4						

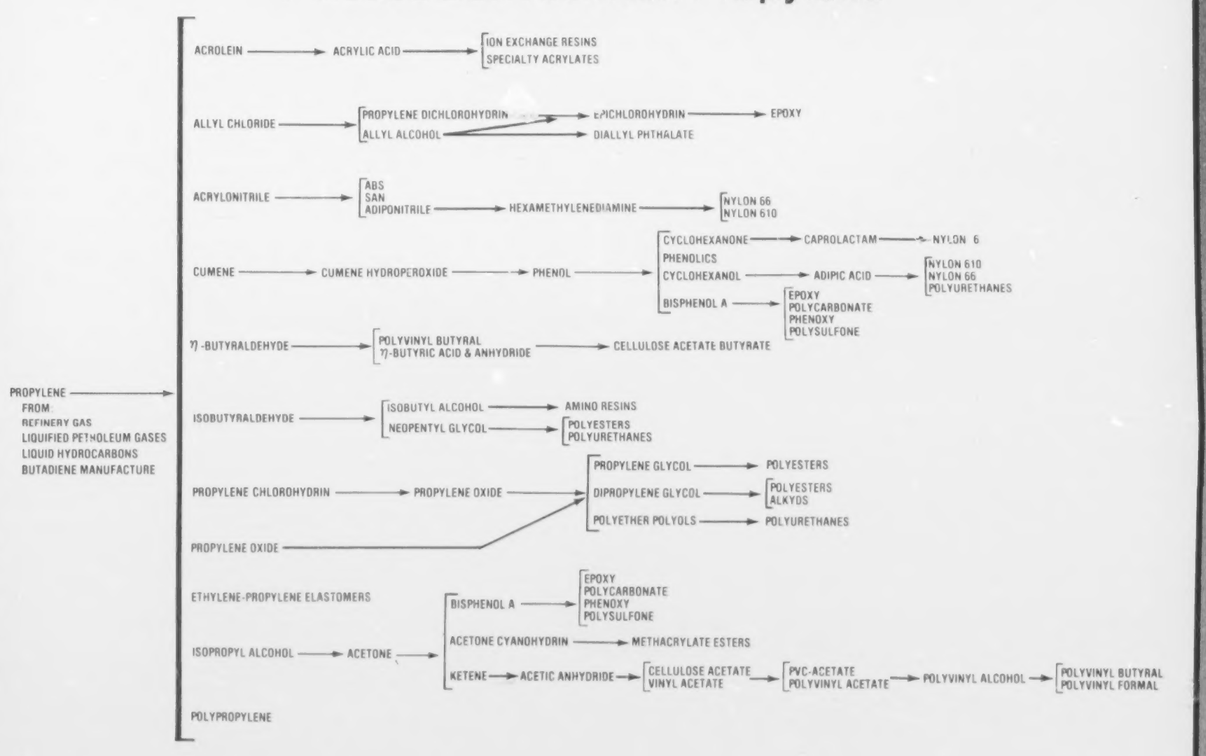
Facts & Figures of the Plastics Industry

PLASTICS FLOW CHARTS

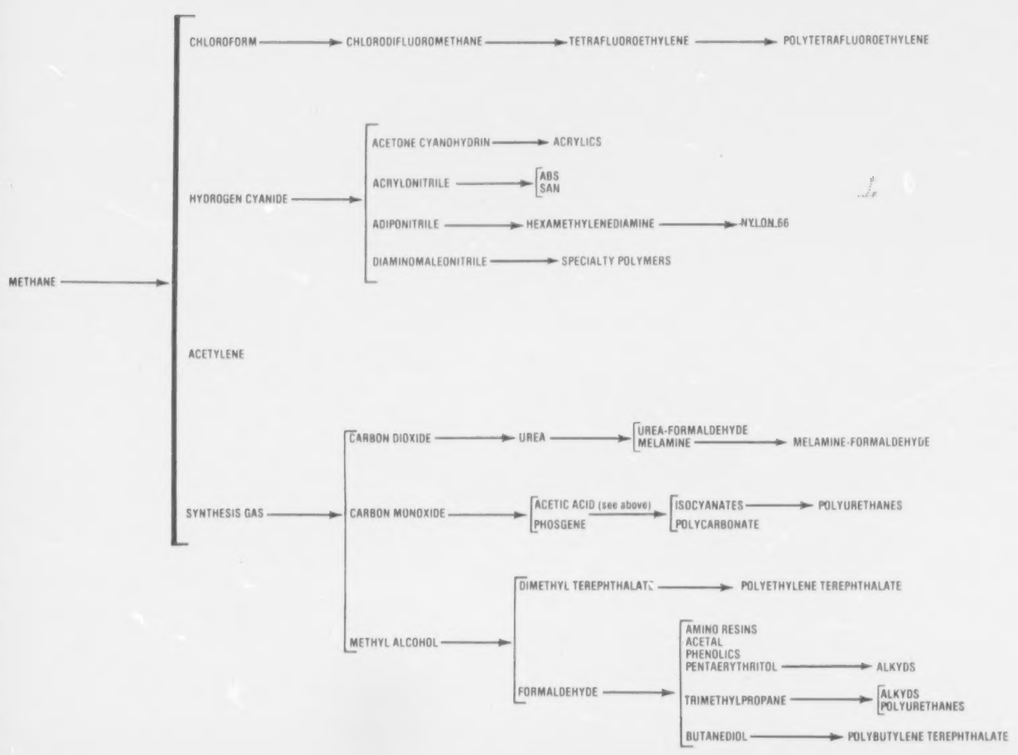
Plastics Derived from Ethylene


ETHYLENE FROM REFINERY GAS LIQUIFIED PETROLEUM GASES LIQUID HYDROCARBONS
ETHYLBENZENE → STYRENE → ABS, SAN, SBR RUBBER, STYRENE-BUTADIENE COPOLYMERS, STYRENE-ALKYD POLYESTERS, POLYSTYRENE, OTHER STYRENE RESINS
POLYETHYLENE → HIGH DENSITY, LOW DENSITY
ETHYLENE/VINYL ACETATE COPOLYMERS
ETHYLENE OXIDE → ETHYLENE GLYCOL → POLYETHYLENE TEREPHTHALATE
ETHYLENE OXIDE → DIETHYLENE GLYCOL, TRIETHYLENE GLYCOL → POLYESTER POLYOLS, POLYESTERS → POLYURETHANES
PROPYLENE COPOLYMERS
ETHYLENE-PROPYLENE ELASTOMERS
ETHYLENE DICHLORIDE → TRICHLORDETHANE → VINYLIDENE CHLORIDE → POLYVINYLIDENE CHLORIDE
ETHYLENE DICHLORIDE → VINYL CHLORIDE → POLYVINYL CHLORIDE & COPOLYMERS
ETHYL ALCOHOL → ACETALDEHYDE → ACETIC ACID → CELLULOSE ACETATE, VINYL ACETATE → PVC-ACETATE, POLYVINYL ACETATE → POLYVINYL ALCOHOL → POLYVINYL BUTYRAL, POLYVINYL FORMAL
ACETALDEHYDE → PENTAERYTHRITOL → ALKYDS
VINYL ACETATE → POLYVINYL ACETATE, POLYVINYL CHLORIDE-ACETATE → POLYVINYL ALCOHOL → POLYVINYL BUTYRAL, POLYVINYL FORMAL
VINYL TOLUENE → POLYESTERS

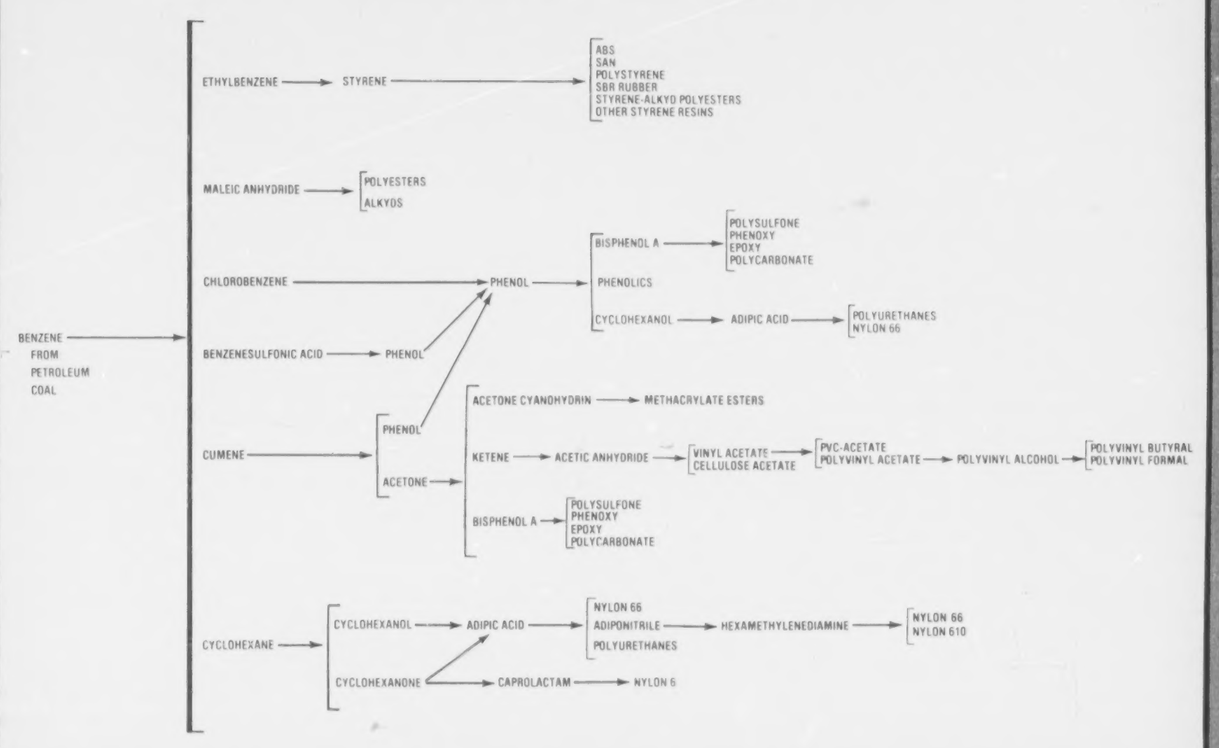
Plastics Derived from Propylene


PROPYLENE FROM REFINERY GAS LIQUIFIED PETROLEUM GASES LIQUID HYDROCARBONS BUTADIENE MANUFACTURE
ACROLEIN → ACRYLIC ACID → ION EXCHANGE RESINS, SPECIALTY ACRYLATES
ALLYL CHLORIDE → PROPYLENE DICHLOROHYDRIN → EPICHLOROHYDRIN → EPOXY
ALLYL CHLORIDE → ALLYL ALCOHOL → EPICHLOROHYDRIN
ALLYL CHLORIDE → ALLYL ALCOHOL → DIALLYL PHTHALATE
ACRYLONITRILE → ABS, SAN
ACRYLONITRILE → ADIPONITRILE → HEXAMETHYLENEDIAMINE → NYLON 66, NYLON 610
CUMENE → CUMENE HYDROPEROXIDE → PHENOL → CYCLOHEXANONE → CAPROLACTAM → NYLON 6
PHENOL → PHENOLICS
PHENOL → CYCLOHEXANOL → ADIPIC ACID → NYLON 610, NYLON 66, POLYURETHANES
PHENOL → BISPHENOL A → EPOXY, POLYCARBONATE, PHENOXY, POLYSULFONE
?)-BUTYRALDEHYDE → POLYVINYL BUTYRAL, ?)-BUTYRIC ACID & ANHYDRIDE → CELLULOSE ACETATE BUTYRATE
ISOBUTYRALDEHYDE → ISOBUTYL ALCOHOL → AMINO RESINS
ISOBUTYRALDEHYDE → NEOPENTYL GLYCOL → POLYESTERS, POLYURETHANES
PROPYLENE CHLOROHYDRIN → PROPYLENE OXIDE → PROPYLENE GLYCOL → POLYESTERS
PROPYLENE OXIDE → DIPROPYLENE GLYCOL → POLYESTERS, ALKYDS
PROPYLENE OXIDE → POLYETHER POLYOLS → POLYURETHANES
ETHYLENE-PROPYLENE ELASTOMERS
ISOPROPYL ALCOHOL → ACETONE → BISPHENOL A → EPOXY, POLYCARBONATE, PHENOXY, POLYSULFONE
ACETONE → ACETONE CYANOHYDRIN → METHACRYLATE ESTERS
ACETONE → KETENE → ACETIC ANHYDRIDE → CELLULOSE ACETATE, VINYL ACETATE → PVC-ACETATE, POLYVINYL ACETATE → POLYVINYL ALCOHOL → POLYVINYL BUTYRAL, POLYVINYL FORMAL
POLYPROPYLENE

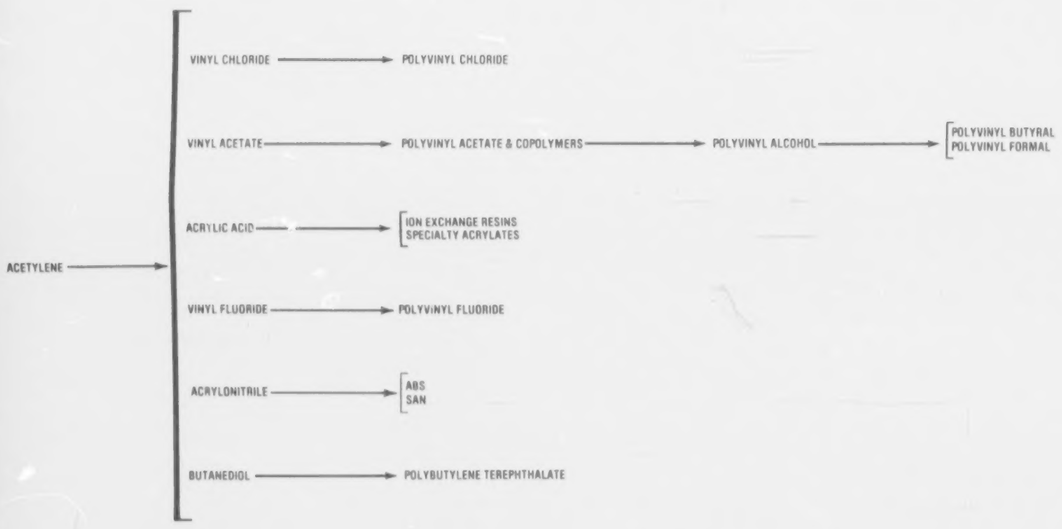
Plastics Derived from Methane


METHANE
CHLOROFORM → CHLORODIFLUOROMETHANE → TETRAFLUOROETHYLENE → POLYTETRAFLUOROETHYLENE
HYDROGEN CYANIDE → ACETONE CYANOHYDRIN → ACRYLICS
HYDROGEN CYANIDE → ACRYLONITRILE → ABS, SAN
HYDROGEN CYANIDE → ADIPONITRILE → HEXAMETHYLENEDIAMINE → NYLON 66
HYDROGEN CYANIDE → DIAMINOMALEONITRILE → SPECIALTY POLYMERS
ACETYLENE
SYNTHESIS GAS → CARBON DIOXIDE → UREA → UREA-FORMALDEHYDE, MELAMINE → MELAMINE-FORMALDEHYDE
SYNTHESIS GAS → CARBON MONOXIDE → ACETIC ACID (see above), PHOSGENE → ISOCYANATES, POLYCARBONATE → POLYURETHANES
SYNTHESIS GAS → METHYL ALCOHOL → DIMETHYL TEREPHTHALATE → POLYETHYLENE TEREPHTHALATE
METHYL ALCOHOL → FORMALDEHYDE → AMINO RESINS, ACETAL, PHENOLICS, PENTAERYTHRITOL → ALKYDS
FORMALDEHYDE → TRIMETHYLPROPANE → ALKYDS, POLYURETHANES
FORMALDEHYDE → BUTANEDIOL → POLYBUTYLENE TEREPHTHALATE

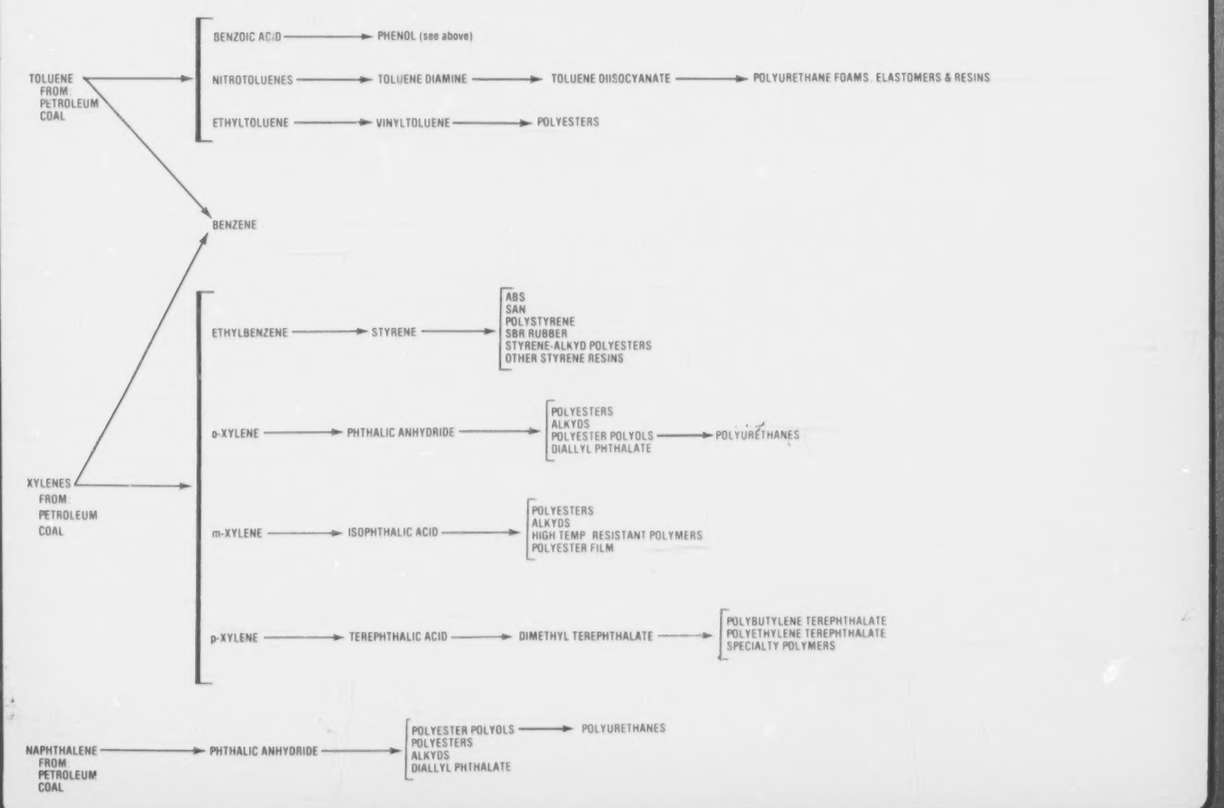
Plastics Derived from Benzene


BENZENE FROM PETROLEUM COAL
ETHYLBENZENE → STYRENE → ABS, SAN, POLYSTYRENE, SBR RUBBER, STYRENE-ALKYD POLYESTERS, OTHER STYRENE RESINS
MALEIC ANHYDRIDE → POLYESTERS, ALKYDS
CHLOROBENZENE → PHENOL → BISPHENOL A → POLYSULFONE, PHENOXY, EPOXY, POLYCARBONATE
PHENOL → PHENOLICS
PHENOL → CYCLOHEXANOL → ADIPIC ACID → POLYURETHANES, NYLON 66
BENZENESULFONIC ACID → PHENOL
CUMENE → PHENOL
CUMENE → ACETONE → ACETONE CYANOHYDRIN → METHACRYLATE ESTERS
ACETONE → KETENE → ACETIC ANHYDRIDE → VINYL ACETATE, CELLULOSE ACETATE → PVC-ACETATE, POLYVINYL ACETATE → POLYVINYL ALCOHOL → POLYVINYL BUTYRAL, POLYVINYL FORMAL
ACETONE → BISPHENOL A → POLYSULFONE, PHENOXY, EPOXY, POLYCARBONATE
CYCLOHEXANE → CYCLOHEXANOL → ADIPIC ACID → NYLON 66, ADIPONITRILE, POLYURETHANES → HEXAMETHYLENEDIAMINE → NYLON 66, NYLON 610
CYCLOHEXANE → CYCLOHEXANONE → ADIPIC ACID
CYCLOHEXANONE → CAPROLACTAM → NYLON 6

Plastics Derived from Acetylene


ACETYLENE
VINYL CHLORIDE → POLYVINYL CHLORIDE
VINYL ACETATE → POLYVINYL ACETATE & COPOLYMERS → POLYVINYL ALCOHOL → POLYVINYL BUTYRAL, POLYVINYL FORMAL
ACRYLIC ACID → ION EXCHANGE RESINS, SPECIALTY ACRYLATES
VINYL FLUORIDE → POLYVINYL FLUORIDE
ACRYLONITRILE → ABS, SAN
BUTANEDIOL → POLYBUTYLENE TEREPHTHALATE

Plastics Derived from Naphthalene, Toluene & Xylenes


TOLUENE FROM PETROLEUM COAL
BENZOIC ACID → PHENOL (see above)
NITROTOLUENES → TOLUENE DIAMINE → TOLUENE DIISOCYANATE → POLYURETHANE FOAMS, ELASTOMERS & RESINS
ETHYLTOLUENE → VINYLTOLUENE → POLYESTERS
BENZENE
ETHYLBENZENE → STYRENE → ABS, SAN, POLYSTYRENE, SBR RUBBER, STYRENE-ALKYD POLYESTERS, OTHER STYRENE RESINS
XYLENES FROM PETROLEUM COAL
o-XYLENE → PHTHALIC ANHYDRIDE → POLYESTERS, ALKYDS, POLYESTER POLYOLS, DIALLYL PHTHALATE → POLYURETHANES
m-XYLENE → ISOPHTHALIC ACID → POLYESTERS, ALKYDS, HIGH TEMP. RESISTANT POLYMERS, POLYESTER FILM
p-XYLENE → TEREPHTHALIC ACID → DIMETHYL TEREPHTHALATE → POLYBUTYLENE TEREPHTHALATE, POLYETHYLENE TEREPHTHALATE, SPECIALTY POLYMERS
NAPHTHALENE FROM PETROLEUM COAL → PHTHALIC ANHYDRIDE → POLYESTER POLYOLS, POLYESTERS, ALKYDS, DIALLYL PHTHALATE → POLYURETHANES

Source: Extracted in part from Stanford Research Institute, Chemical Origins & Markets.

COMMITTEE ON RESIN STATISTICS

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